DOCUMENT RESUME

ED 147 976 EA 010 174

AUTHOR	Leyland, George
TITLE	A School Districting Feasibility Study. The Problem in Clark County, Nevada and a Technical Solution Using Available Computer Technology.
INSTITUTION	Clark County School District, Las Vegas, Nev.
PUB DATE	[Oct 74]
NOTE	90p.; Appendix VII may not reproduce clearly due to small print size
EDRS PRICE	MF-$0.83 HC-$4.67 Plus Postage.
DESCRIPTORS	Bus Transportation; *Computer Programs; Computer Science; *Cost Effectiveness; Elementary Secondary Education; *Feasibility Studies; School Districts; School Integration; *School Redistricting; School Zoning; Site Selection; *Student Transportation
IDENTIFIERS	*Clark County School District NV

ABSTRACT

A cooperative effort between the National Institute of Education and the Clark County (Nevada) School District demonstrated the practical use of available computer-assisted techniques for helping local communities allocate students to schools and for solving other problems that occur during districting efforts. By using available computer technology, local needs were met in school site evaluation, school zone boundary planning, and bus route planning while meeting the standards required by the court-ordered desegregation effort. The use of these techniques can result in minimizing fuel costs of busing and in cutting the administrative effort required by the school planning process by approximately one third. Appendixes include the criteria for local involvement, the technical approach used, estimated man-months of effort expended, the project schedule, past approaches, a bibliography, and a glossary. (Author/IRT)

****
* Documents acquired by ERIC include many informal unpublished *
* materials not available from other sources. ERIC makes every effort *
* to obtain the best copy available. Nevertheless, items of marginal *
* reproducibility are often encountered and this affects the quality *
* of the microfiche and hardcopy reproductions ERIC makes available *
* via the ERIC Document Reproduction Service (EDRS). EDRS is not *
* responsible for the quality of the original document. Reproductions *
* supplied by EDRS are the best that can be made from the original. *
****

ED147976

U S DEPARTMENT OF HEALTH.
EDUCATION & WELFARE
NATIONAL INSTITUTE OF
EDUCATION

THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL NATIONAL INSTITUTE OF EDUCATION POSITION OR POLICY

SCOPE OF INTEREST NOTICE

The ERIC Facility has assigned this document for processing to: EA | TM

In our judgement, this document is also of interest to the clearinghouses noted to the right. Indexing should reflect their special points of view.

A SCHOOL DISTRICTING FEASIBILITY STUDY

THE PROBLEM IN CLARK COUNTY, NEVADA
AND A TECHNICAL SOLUTION
USING AVAILABLE COMPUTER TECHNOLOGY

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY

Clark County School District

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC) AND USERS OF THE ERIC SYSTEM."

Prepared
by

George Leyland
Consultant
for
The Center for Census Use Studies

EA 010 174

TABLE OF CONTENTS

SUMMARY OF TECHNICAL PROPOSAL . . . . D

PART I: THE SCHOOL DISTRICTING PROBLEM IN (CLARK COUNTY, NEVADA) I-1

- INTRODUCTION I-2
- LITIGATION I-2
- THE PLAN I-5
- PREPARATION FOR IMPLEMENTATION I-5
- TRANSPORTATION I-6
- CONCLUSION I-8

PART II: A TECHNICAL SOLUTION USING AVAILABLE COMPUTER PROGRAMS II-1

- BACKGROUND II-2
- GOALS II-3
- MULTI-AGENCY INVOLVEMENT II-4
  - A. National Institute of Education II-4
  - B. Clark County, Nevada II-5
  - C. Bureau of the Census II-6
- TECHNICAL ADVISORY COMMITTEE II-6
- PROBLEM DEFINITION II-7
- DATA AND POLICY ISSUES II-10
  - A. Student Characteristics II-11
  - B. School Zoning II-12
  - C. Transportation II-14
  - D. Population Projection II-15

TABLE OF CONTENTS Con't.

TECHNICAL APPROACH II-16

PROGRAM COMPONENTS II-16

PROPOSED SOLUTION COMPONENTS II-18

COST - BENEFIT SUMMARY II-20

A. Cost II-20

B. Benefit II-20

CONCLUSION II-27

PART III: APPENDICES III-1

I. CRITERIA FOR LOCAL INVOLVEMENT III-2

II. TECHNICAL APPROACH III-4

III. ESTIMATED MAN MONTHS OF EFFORT III-17

IV. PROJECT SCHEDULE III-20

V. PAST APPROACHES III-22

VI. BIBLIOGRAPHY III-24

VII. GLOSSARY III-29

SUMMARY

At the present time, Clark County, Nevada, is experiencing a variety of problems that relate to school districting: assigning students to schools to reduce racially separate facilities, assigning students to buses, setting up economical bus routes, evaluating the impact of racial mix in schools, and restructuring student programs to assure minority representation.

A cooperative effort between NIE and the Clark County (Nevada) School District, using available computer programs, could demonstrate the practical use of computer-assisted techniques for helping local communities allocate students to schools and solve other problems that occur during districting efforts. By using available computer technology, local needs can be met in the planning of districts and bus routes while meeting the standards required by the courts, school administrators and community groups. The use of these techniques can result in minimizing fuel costs for bussing and in cutting the administrative effort required by the school planning process by approximately one third. Thus, by the appropriate use of existing technology, substantial benefits can accrue to local school districts.

D

Technical Approach

The development of a practical computer-assisted school districting procedure is feasible. A computer-assisted procedure can be used by local school planners to evaluate and inter-relate three critical planning factors: facility use, district boundary lines and school bus transportation routes. The use of this procedure would enable local school planners to improve their level of management. More importantly, this procedure would make possible the redirection of significant local educational resources to the primary function of the school system - the teaching of students.

Over the past eight years, the Census Bureau has been involved in the development of specialized technology for small area data analysis. The pieces of that technology can be joined together to develop a practical school districting procedure for local school planners. This cooperative effort between the National Institute of Education and Clark County, Nevada is proposed to demonstrate the use of Census technology in a county school environment. Clark County has been chosen as a test site because school planners from Clark County have shown an interest in the Census programs and a commitment to the use of automated school planning techniques in school administration.

The development of a practical computer-assisted school districting procedure is a complex undertaking. A local school district, using this technique, can improve its ability to:

Code student addresses to a common geography using computerized geographic files

Map student locations using the computer

Redraw school district boundaries on an interactive basis using digitizer technology

Construct district boundaries by computer according to a flexible set of constraints

Evaluate transportation routes for school buses

Analyze financial alternatives and implications of new locations

Project school population

Prepare detailed summary plan evaluation reports

All of these elements can then be integrated into a standard procedure so that the benefit of using computer technology for school planning is maximized.

Immediate Applications

Discussions with local school planners in Las Vegas have yielded the following local priorities:

1. School site evaluation
2. School zone boundary planning
3. Bus route planning

When the geocoding of students and the population estimation techniques developed by the Census are used, in conjunction with resource allocation and computer mapping techniques, solutions in all three priority problem areas can be found.

Suburban growth requires the expansion of school facilities in the outlying areas of the county while urban decline makes excess school capacity available in the city. Balancing the building of new schools and bussing of students to old ones against each other is a difficult but necessary task. In attempting to solve this problem, several site plans must be analyzed. The selection of a new school for current enrollments can be accomplished by allocating a proportion of the projected total enrollment using the CRAM resource allocation model to each existing school. The distribution of unallocated students would indicate the area(s) which are most in need of a new school. By using projected enrollments, local officials can see how each new site would fit both current and predicted future needs. Comparing the location of unallocated students to the locations of school owned property can indicate the "best" site for alternative facility development. A means of manipulating school boundaries according to any design and testing alternative zone pattern would help to increase the flexibility of the school planner in examining alternatives.

Each year school attendance zones must be established for 77,000 students. Changes in neighborhoods dictate major changes in some schools and the reassignment of classroom capacity in most schools. Court ordered integration must also be satisfied in formulating new district plans. Balancing the demands of quality education, neighborhood needs and court orders makes the drawing of school zones a difficult task. In response to this problem, the location of students can be input to several models through geocoding and mapping. Using an interactive system, alternative attendance areas and their student composition can be examined. In addition, sample districts can be generated by the computer using certain minimum distance or population mix requirements. Each of these solutions can be displayed and worked with at public meetings as well as at technical sessions with administrators from each local school.

Bus route planning includes the establishment of both efficient bus routing for all students and acceptable plans for the use of bussing in the integration of schools. Any bussing plan also depends heavily on the school zoning plan and interacts with that plan because of the high costs of school bussing operations. In response to this problem, the use of geocoding also allows the current student population to be located and assigned to bus routes. With integration as a goal, then the zoning problem is related to the bussing problem and an iterative approach should be used to develop alternative solutions. Even though the district boundaries must be set before bussing needs can be estimated, the actual assignments of students should be done as an iterative process. Once the boundaries and facilities are decided upon, a bus-stop domain can be generated for groups of students. Using the CARPOL method, bus-stop domains can be generated based on students geocoded to block or nearest intersection. Once these domains are generated, a minimum path program can generate efficient bus routes. Approximate bus routes can also be calculated by taking the centroid of each bus-stop domain and using these points to generate a network file for use in a minimum path program. The resulting bus routes let the school planners quickly evaluate basic alternatives and define the criteria for choosing the final route.

The immediate use of this technology is currently limited to local school officials in Clark County, Nevada. While the technical development of Census techniques will continue without an overall systems effort in this area, the development will be limited in scope and will be difficult to adapt to other communities. A comprehensive, adequately funded, school planning systems approach is necessary to get the maximum national impact from the application of Census technology to local school needs.

PART I: THE SCHOOL DISTRICTING PROBLEM

(CLARK COUNTY, NEVADA)

Introduction

Las Vegas, Nevada is the seat of Clark County, an area that spreads 8,000 square miles across the desert. According to the census of 1970, the county had a population of 273,288, of which 10.5 percent were members of some racial or ethnic minority group. The county's school district population is 78,682 with 15,880 non-white students or 20% ethnic minority students.

The Clark County School District and the city of Las Vegas over the years developed a tradition of segregation similar to that of urban schools in many other cities. As in other cities, school segregation in Las Vegas resulted, not from laws requiring it, but from racially separate housing patterns upon which neighborhood school attendance was based.

In Las Vegas, the neighborhood school policy established a cluster of racially separate elementary schools on the west side of the city where the majority of black residents live. Junior and senior high schools in the city were desegregated because black students and other minorities were traditionally transported to those schools by bus. After World War II, there was an increase in the black population living in Las Vegas. While additional elementary schools were constructed to meet elementary student enrollment, no secondary schools were constructed in the Westside. This was at the request of black community leaders, who took the position that the construction of new units would extend segregation to the secondary schools.

Litigation

In May 1968, the NAACP Legal Defense and Educational Fund, Inc., filed a suit against the Clark County School District.[1] The suit alleged that the 5th and 14th Amendments to the Constitution were violated by the attendance of black pupils in the elementary schools on the west side. The plaintiffs argued that white students were bused to white schools although the west side schools were closer to their homes; and that black elementary students found it difficult to transfer from one school to another. Finally, it was charged that the school board had manipulated elementary school attendance zones to perpetuate segregation.

A decision in the case was handed down by the United States District Court for Nevada in October 1968. It ruled that the Las Vegas elementary schools were unlawfully segregated and ordered the school board to submit an integration plan. The plan submitted was esentially a "freedom of choice" option permitting parents to transfer their children to the west side schools.

---

[1] *Kellar* v. *Guinn*, Nos. 71-2332, 71-2340 and 71-2422. See also *Kellar* v. *Guinn* 456F 2d 100 (Court of Appeals, 9th Cir.) Pending on Appeal, Supreme *Court* of the United States, 72-341 (1972).

Under the plan, two of the elementary schools on the west side were designated as "magnet" or "prestige" schools to attract white students. Both schools, C.V.T. Gilbert and Jo Mackey, were to be operated with a low teacher-pupil ratio and receive additional supportive services and equipment from the district. The court approved the plan and ordered that a progress report be filed with the Court on March 1, 1970.

After reviewing the report, the Court found that the plan had not resulted in integration. The Court said:

> The neighborhood school concept must be abandoned to accomplish integration in a racially segregated residential area. Because of the demonstrated reluctance of white parents to volunteer their children for education in the Westside schools, the burden of accepting busing to accomplish elementary school integration has been placed on the black parents. While the latter have evinced an increasing acceptance of such busing for their children, it cannot be inferred from the evidence before the Court that the present plan will ever eliminate an almost one hundred percent population of black students in the Westside elementary schools so long as such schools are maintained and operated.2/

The district was ordered by the Court to come up with a plan that would desegregate the schools in the west side area. The enrollment of black students, the Court said, "shall not exceed fifty percent of the total student enrollment in such grade."3/

After consulting with many community organizations and listening to suggestions from county residents as to how to desegregate the west side schools, school officials finally adopted the "Sixth Grade Center Plan,"4/ which was submitted to the school board. Although the school board already had decided to appeal the decision, it approved the plan which was accepted by the Court. In February 1972, the Appeals Court turned down the board's appeal and affirmed the lower court's desegregation decision. But legislation passed by Congress in June slowed down the district's plans to implement the Court's ruling in September.

2/ Judgment and Decree of U.S. District Judge Bruce R. Thompson, U.S. District Court, District of Nevada, dated December 3, 1970, p. 2.

3/ Ibid. pp.5-6.

4/ Under the plan, only the sixth grade would be taught in each of the predominantly black elementary schools on the west side. Black children in grades 1-5 were to be transported to elementary schools outside of the west side area, while white sixth graders were to be transported to the west side to attend one of the sixth grade schools.

Congress adopted, on June 8, 1972, the Broomfield Amendment as part of the Higher Education Act. The amendment suspended until January 1, 1974, all court-ordered school desegregation plans that were subject to appeal through the courts or until the appeal process was terminated. It banned the use of Federal monies for school busing and prohibited busing that resulted in children attending an "inferior" school or impairment of their health. Some segments of the Clark County community believed the Broomfield Amendment negated the Court's desegregation order.

The legal entanglements of the school district deepened in August 1972 when the United States District Court issued a "show cause" order against the school board, after the Las Vegas League of Women Voters filed a suit alleging that the board was in contempt of the desegregation order. The board argued that the Broomfield Amendment provided a delay in executing the desegregation order of the Court and until all appeals were exhausted, the Court's ruling should not go into effect. The United States District Court ruled, however, that the Broomfield Amendment was not applicable to the school district because it could not be applied retroactively to the Clark County school case.

Then in September 1972, a citizens' group composed of white parents opposed to the sixth grade center plan and named "Operation Bus Out," filed suit in the Nevada District Court, asking the court to issue an injunction against the school district to prevent it from implementing the plan. The central position of the Bus Out group, was that the busing requirements needed to implement the sixth grade center plan would cause financial loss to many families because the value of their homes would be diminished if their children could not attend the schools in their neighborhood.

In addition, the anti-busing group's complaint stated the desegregation plan was a violation of the Nevada Constitution which provided for a uniform system of common schools. The State court agreed and issued the injunction. The injunction closed all the elementary schools and affected 30,000 elementary school students in the county that were under the U.S. District Court's two-year-old ruling.

School officials were now in the position of defending the Federal Court's right to retain jurisdiction of the school case. The school board turned to the Nevada State Supreme Court and petitioned the Court to lift the injunction imposed by the lower Court.

School officials, while awaiting an opinion of the Nevada State Supreme Court, proceeded to put into effect the Sixth Grade Center Plan despite the injunction. In October 1972, the Nevada State Supreme Court ruled for the school district and said in effect that a State court cannot interfere with a Federal court order.

The Plan

The Sixth Grade Center Plan approved by the school board created sixth grade centers out of the six black elementary schools in Westside Las Vegas. This meant that all white students in the sixth grade would be bused to one of the centers, while all black sixth graders would attend their neighborhood school (now a Sixth Grade Center), if they lived within the environs of the Westside. Black sixth graders who lived outside the perimenter of the Westside were to be bused to the cluster of sixth grade centers just as their white counterparts were transported by bus. All black students in grades 1-5 would be bused out of the neighborhood, while white students in grades 1-5 would attend their neighborhood schools.

Three modifications of the plan were allowed by the Court. First, an additional school, Quannah McCall, was added to the six elementary schools designated as sixth grade centers. It was selected because it lay on the fringe of the Westside, and its student population was 35 percent black. Future enrollment statistics for Quannah McCall projected an increase of black students attending the school that would exceed the 50 percent enrollment in any one school or grade which was stipulated by the Court. Second, kindergarten children would attend school in their own neighborhoods. School officials felt that since kindergarten children attended school for only 2 1/2 hours a day it was unreasonable to transport the children out of their neighborhood. As a third modification to the plan, the board, at the suggestion of parents, exempted schools that were already integrated through integrated housing patterns.

While the December 2, 1970, decision of the Court applied to the elementary schools within Westside Las Vegas, the effect of the decision also was to integrate all elementary schools that were previously all-white in Las Vegas, North Las Vegas, and the unincorporated areas bordering Westside Las Vegas. Black children in grades 1-5 were bused out of the Westside to previously all-white schools. White students in grades K-5 would attend their neighborhood schools.

Thus under the Sixth Grade Center Plan the burden of busing fell upon the black student population. Under the plan, white children would be bused for only one of their six elementary school years, while black children are transported five of six years.

Preparation for Implementation

Once litigation concerning the legality of the Sixth Grade Center Plan was settled, the school district returned to the task of preparing schools, parents, teachers, staff, and students for the opening of the 1972-73 school year. Textbooks were transferred, furniture was replaced and purchased, the Library-Media Centers were reorganized for the sixth graders.

New school assignment guidelines were developed to assign black 1-5 grade students to non-westside schools and assign all 6th grade white students to Sixth Grade Centers with the exception of those students living within the attendance area of exempt schools.

The Clark County School District had previously adopted the Feeder School Concept. This concept allowed groups of elementary schools including westside elementary schools to feed into a certain junior high school and in turn this junior high school would feed into a designated high school.

The implementation of the sixth grade center plan created tremendous zoning problems in trying to keep the feeder school concept. Overnight the responsibility of student zoning doubled in complexity in trying to keep students in the feeder school system and at the same time trying to maintain an equal ethnic distribution of students in all elementary schools. However, this was achieved with many hours of overtime. Attendance zones were established and in May 1972, parents received letters explaining the law, registration procedures, their child's new school assignment, and the school district's zoning guidelines.

Two orientation sessions were held for parents, teachers and students. The affected white students joined their parents in visiting the sixth grade centers to talk with their new principals and teachers, and to become familiar with the educational environment of their sixth grade center. Black parents and students attending schools outside Westside Las Vegas were invited to meet with school personnel and become acquainted with their 1-5 schools.

Teachers attended a three-day workshop for which they were paid sixty dollars (for each day of attendance) to discuss the legal reasons for the desegregation program, the sociological and psychological impact of the program upon the school district, curriculum programs, counseling, and how to promote human relations in class and in the school. Other scheduled sessions for teachers included: discussions of health and welfare, drug abuse, and the school district's special programs and activities.

The transfer and assignment of teachers were dependent upon the teachers' previous assignment. All sixth grade teachers were automatically assigned to a Sixth Grade Center. Vacancies within the Center were filled by teachers who desired to transfer to a Sixth Grade Center. Sixth grade teachers were not allowed to transfer to a lower grade level if they had failed to request a transfer as early as May 1972. Teachers who taught in grades 1-5 and were assigned to a school that became a Sixth Grade Center were reassigned. Other primary and intermediate teachers who were not chosen to continue in their present school were reassigned to schools of their own choice. To assure that all elementary school staff were effectively integrated, no more than 20 percent of the Sixth Grade Center personnel were to be black.5/

Transportation

Although the Clark County School District covers an 8,000 square mile area, the transportation of children by bus is accomplished by the efficient operation of the Department of Transportation. The department has developed

---

5/ Mimeographed publication, Sixth Grade Plan, 1972-73, Clark County School District, Las Vegas, Nevada, p. 42.

a training program that exceeds the training requirements of the State of Nevada. The State requires that a school bus driver receive ten hours of driver training to be eligible to drive a school bus. But the Director of Transportation for the Clark County School District requires that each driver receive 40 hours of driver training a year. The department's mechanics are required to attend State schools, and when necessary, schools outside the State to maintain their mechanical skills. The results have been a low rate of the breakdown of buses, few accidents, and an excellent safety record.

During the 1971-72 school year, the buses rolled up 2 million miles without a major accident. They carried more than 14,000 students a day and were involved in a total of only 44 minor accidents. According to the Director of Transportation, those accidents were usually, "the fault of the other motorist and not the bus driver. They were just minor collisions with a dented fender or scratched paint" and no children were seriously injured. The buses have many safety features, including padding on the backs of seats. During the 1972-73 school year 196 school buses carried 20,000 children to and from school daily. In measured time and distance, the longest ride before desegregation was an hour and a half and covered a distance of 50 miles. Since desegregation has taken place this remains unchanged. The average distance and time of ride for most students was and remains 11 miles and 30 minutes.

For eleven years, the department has used a triple bus schedule for transporting children in the city or nearby suburbs. It has proved to be the most efficient means of moving the children from home to school, and from school to home in Clark County. To gain the best use of its buses and drivers, school officials delegated to the transportation officer authority to determine the time schools open in the county. They open at forty-five minute intervals; thus, the high schools open at 7:30 a.m., junior high schools at 8:15 a.m., and elementary schools at 9:00 a.m. This allows a driver enough time to pick up all high school students on his route and get them to school by 7:30 a.m. After he leaves the high school, he doubles back and picks up junior high school children and reaches school by 8:15 a.m. He then picks up the elementary school children who arrive at school by 9:00 a.m. Since the average riding time is 30 minutes from the first pick-up point to the school, the drivers have 15 minutes of dead time to pick up their second and third runs. Therefore, one bus driver expends an hour and a half between 7:30 a.m. and 9:00 a.m. transporting students to school. The driver has enough time between runs to go from a high school to a junior high school, and finally to an elementary school on three different but geographically related routes.

The primary effect of the desegregation plan upon the school district's budget related to the increase in the number of students the buses were to carry. To meet that need, the school district purchased 30 new vehicles—each costing $18,000 apiece. The total budgetary cost of desegregating the elementary schools was $1,544,196, of which the transportation department's share was $855,494. Some $540,000 of the money was spent for the purchase of new buses. The remaining money was used to pay for drivers, mechanics, gas, oil, tires, and parts, servicemen, insurance, and employee benefits. The transportation cost to the school district to desegregate the schools represents only 2.3 percent of the district's 1972-73 budget of approximately $64 million.

Since the Court's order was aimed at desegregating the elementary schools, the order left untouched the tradition of busing minority and white students to junior and senior high school. The provision to use a standby vehicle if a child becomes ill was not changed; buses used for extracurricular activities were not changed (since funds for those activities were limited before the desegregation plan) and the triple scheduling of buses was not changed—merely expanded.

Conclusion

Despite the legal entanglements of the school district, the protest of anti-busing groups, and general community confusion over desegregation, the Sixth Grade Center Plan is proving its worth—from the standpoint of education as well as desegregation. "The Sixth Grade Center educational programs" one official reported, "are much better than the programs the neighborhood school had last year." The administrator attributed the success of the Center to their "CORE" curriculum consisting of language arts, social science and mathematics, or social science and science; activity programs that include: rocketry, ceramics, square dancing, foreign languages (Spanish and German), a drill team, photography, leathercrafts, modern dance, an exchange program with junior high schools; and the child centered concept of the curriculum rather than a content-oriented educational program.

A report published by the Clark County School District in July 1974 on the progress of integration in Las Vegas stated:

> In a considerable number of instances, black students made significant increases when pre-integration scores were compared to post-integration scores. These improvements coincide with rather stable results on the part of the white sample.
>
> The results of this study indicate a substantial difference between white and black achievement. It would appear that this difference will not be overcome in a short period of time. Although the achievement profiles of the black population are still low, the study does suggest a positive trend.
>
> Continued evaluation should be encouraged to determine the subsequent affects of desegregated education for the students in the Clark County School District.6/

6/ Desegregation Report, July, 1974, Clark County School District, Las Vegas, Nevada, p. 21.

But the politics of desegregation in Clark County continue. In March 1973, legislation to end busing in Clark County was introduced in the Nevada State Assembly. This effort was defeated when the Committee on Education refused to report out the bill. School officials testifying against the measure said busing was a "moot point" for legislative action because desegregation through busing had been accomplished successfully in Clark County.

PART II: A TECHNICAL SOLUTION USING AVAILABLE COMPUTER PROGRAMS

BACKGROUND

The primary mission of schools is to educate. But the three important ancillary activities consume an inordinate amount of staff time and resources that could be applied elsewhere: school site selection, establishment of attendance areas and school bus routing.

School site selection and facility modification costs in excess of $500 million per year. Next year billions of dollars will be spent on student transportation in the nation--thus making up the largest, costliest, and most complex transportation system in the country. Site selection and transportation costs continue to increase year after year, and only a few school districts retain experts in order to study these problems. Most decisions regarding both school sites and bus routes are made by local school personnel whose main function is in some other area of school administration.

School zoning, while not requiring large capital costs, represents a major activity for all school districts. The formulation and publicizing of school district boundaries represents a major summer activity for most school districts. In addition, adverse public reaction to boundary decisions and court-ordered adjustments in school districts for racial or economic reasons can turn a difficult problem into a nightmare for ill-equipped school planners.

This feasibility study outlines the steps necessary to develop a practical school districting system. The system will enable school planners to explore and evaluate site development and expansion, attendance area boundaries, and transportation needs. The approach outlined avoids oversimplifying the problem and uses a man/machine interactive process to meet the planning needs of the local communities.

Applying new technology to school site issues on a practical and realistic basis is clearly possible, but the application is still costly and time consuming. A systems approach must be used to organize the components of the problem into a workable mixture of data, technology and people. The school site location problem must be considered in total without the simplifying assumptions that might limit the use of the tools being developed. Formulating the system with such a broad scope is essential, however, if the end product is to be useful in a variety of communities.

The development of a solution for each part of the total problem can be undertaken independently of work on other parts. Moreover, such development can be justified independently since the benefits of each solution far exceed the costs of its development. Further, since the components of the system can be used independently by localities, these components can be distributed while the full system is still being developed and tested in Las Vegas. However, in order to maximize the impact of these methods and to increase their acceptance after transfer, commitment to a total systems approach is strongly recommended.

The collaboration of the National Institute of Education and the Clark County (Las Vegas, Nevada) School District will be needed to implement the steps outlined in this report. These two groups aided by other Federal, State and local agencies, must work together to develop solutions to local school planning problems which will be helpful to many other local school districts in the Nation.

The remainder of this report defines the problem of school districting in technical detail and identifies many of the issues associated with the general districting problem. Past approaches are discussed in terms of their limited usefulness to school administrators faced with real school districting problems. A new approach, based on solving a mixture of associated school location problems through a complex automated support system is evaluated in terms of its overall effectiveness. The use of Clark County, Nevada as the test development site for the project is explained in terms of their previous work in using basic Census geocoding technologies.

A technical description of the methods to be used is contained in the appendixes. Summaries of the Census developed technology, a time and cost estimate for the project, and material describing the current school districting activities in Clark County are presented.

Goals

The development of a fully automated school location system has the following goals:

- To provide more detailed and accurate plans for school use and transportation than is possible through the manual efforts.
- To provide plans with better utilization of staff and fewer delays than is possible using manual efforts.
- To provide a better and faster means of testing the sensitivity of plans to changes in the population growth or the demands of new education policy than is possible by using manual efforts.
- To provide better control over non-teaching operations so that a more effective use of resources and a better reaction to crisis situations will be possible than when manual methods are used.

Better plans for school use and bus transporation can be evaluated by the lack of adjustments required after the final plan is made public, the ease of justifying the plan at public meetings, the conformity of the plan to court requirements, the money saved on facilities and buses, the increased safety of students, and the integration of available public transportation and building facilities with school district needs.

Better use of staff would include the decreased need to have temporary employees and intensified involvement of experienced school planners in critical decisions. An automated system should also be able to deliver alternative plans measurably faster than with manual plan construction.

Tests of the sensitivity of plans to changed requirements include the use of population projections, examining new and unexpected development potential, neighborhood growth or decline, changes in education policy toward racial, ethnic or economic integration, the provision of services for the retarded or handicapped and changes in school hours, facility use and class size.

Better management control will be possible using the automated system since estimates of bid cost, adjustments, arbitration and measures of efficiency will be standardized and quantified. Likewise, school management can react more quickly and more sensibly to crises caused by weather, natural disaster or other causes because more complete information will be available.

Multi-Agency Involvement

This feasibility study was undertaken because of the simultaneous joint interest of personnel in these governmental agencies: National Institute of Education, the Clark County (Nevada) School District, and the Bureau of the Census.

A. National Institute of Education

The National Institute of Education (NIE) is currently studying educational methods and policies which have national impact. At the same time, NIE has a strong interest in helping local school districts to solve immediate local problems. Furthermore, NIE is interested in studying the feasibility of applying new technology to solve educational problems. These combined interests suggested that NIE become involved in solving specific school planning problems.

Clearly, the National Institute of Education is interested in projects with a high probability of solving specific local problems. But NIE also has an interest in helping to solve problems facing a large number of school districts in the Nation. This project should not only provide a methodology practical for the specific problem in Clark County, but one which can be transferred to other communities and with a similar potential for successful use.

Critical decisions on school locations are routinely made by local districts throughout the Nation. Interest in the use of technology to help locate schools is widespread. There is documented interest and a past record of investment in solving these problems in many local communities. On-going projects related to school location problems currently exist in New York, Los Angeles, Seattle, Boston and Miami. We know of other smaller projects that are being conducted in a variety of local areas through national consultant groups, such as Mathematica, Public Technology, Inc., Boeing Computer Services, General Electric, as well as local consulting groups.

21

In addition to helping solve some of the most expensive and controversial problems faced by school planners, this project can be helpful to the study of education policy development. The project provides an environment in which local decisionmakers can work with experts on technical problems with policy implications. Such an environment can provide a detailed history of the adoption of technical innovation by local school districts. In the critical area of school districting and site location, all decisions which are made can be documented. In this manner, this project provides the impetus for an exploration of the decisionmaking process regarding both the acceptance of technological innovation, as well as site selection policies.

NIE is expected to be an active partner in developing the techniques used in the project and in evaluating their usefulness. Proper development and evaluation will facilitate the transfer of the new technology to other sites. The project will obviously benefit through the involvement of NIE professionals. However, those same professionals will also benefit from the experience of using new data analysis techniques and in relating this project experience to other problems.

B. Clark County

The Las Vegas area, along with many other school districts, is faced with immediate problems. Among these are the normal school site selection problems in a dynamic changing urban environment and expanding suburban development. But, in addition, Clark County is faced with the problems of racial imbalance and school transportation economies. At the same time, Clark County is faced with the need to develop meaningful policies and programs which relate directly to the use of school facilities. This year, for instance, a full school lunch policy and program must be developed, taking into consideration the numbers and backgrounds of all students attending each school.

Clark County desires assistance in studying and proposing alternative school districting plans and transportation plans which would meet the Court-dictated guidelines for racial balance. All such alternatives must, realistically, meet the objectives of local political leaders and must be acceptable to the general public if undue controversy is to be avoided. Local leaders know that the use of recently developed technology will assist them in studying alternatives, evaluating the impact of each alternative, and in presenting these alternatives to the community.

Clark County school district personnel are aware that the effort in developing this technology is immense. Most of the basic geographic base file and address matching technology required for this project, however, has been developed cooperatively by several local agencies in Clark County. Local school planners are already using parts of this technology on a limited basis for their school planning but they recognize the need for more workable tools. Moreover, local school planners realize the potential of the technology if it is extended to meet their full needs. They recognize how the extension of their basic tools will relieve them from the slow and tedious task of manually reassigning students to schools. These school planners realize the usefulness of developing a system which can be used year after year to solve school location problems instead of relying on methods which force them to retrace the same steps each year to develop the basic material for school redistricting.

A positive benefit is necessary if the program is to be fully accepted by a local school district and if it is to be transferred to other sites. Clark County will benefit substantially by the practical application of newly developed computer technology to their school location problems. A cost benefit analysis outlined in this report shows a significant net benefit to other local school districts as well.

Technical manpower from NIE will be necessary in developing and testing the first system; but the role of Federal Government will be diminished in the later phases of the project. Other school districts should be able to use the full system in subsequent years without assistance from Federal agencies.

Local planners are concerned about developing decisions which affect school locations so that local needs are satisfied and not ignored in the proposed solutions. It is anticipated that by giving local areas this advanced planning technology, Federal regulations and court orders in local problems can be accomodated. New alternatives are expected to be generated faster and with fewer errors than is possible without this technology. Further, a more efficient use of resources is anticipated and the complex needs of educating students will be more readily understood.

Local planners see these tools as basic materials which will help them to provide more accurate data on students and where they live. The methods will free planners from archaic and obsolete-methods of zoning which do not allow them to take into consideration the factors to achieve the highest quality of education for students in their area through the efficient use of school resources.

C. Bureau of the Census

The Bureau of the Census, through the Census Use Study, has been involved in showing local communities how to use computer techniques in mapping, address coding, resource allocation, carpooling and data analysis.

School districting problems (when considered in terms of site location, current population needs, transportation, future population growth, and financial resources of the community) are an ideal test for the modification and application of the technology developed at the Census Bureau.

Interagency Technical Advisory Committee

The involvement of several governmental agencies in a technically oriented program is awkward unless each of the participating agencies agree to the scope and objectives in the planning stages. Clearly, there is mutual interest and benefit among Federal, State and local agencies who wish to participate in developing the school zoning system. The involvement of additional agencies assures a higher quality product and a more readily transferrable set of methods, but this involvement might also bring delays and occasionally extraneous demands on the project staff. These delays and distractions must be avoided by screening all changes in the work plan through a multi-agency technical advisory committee.

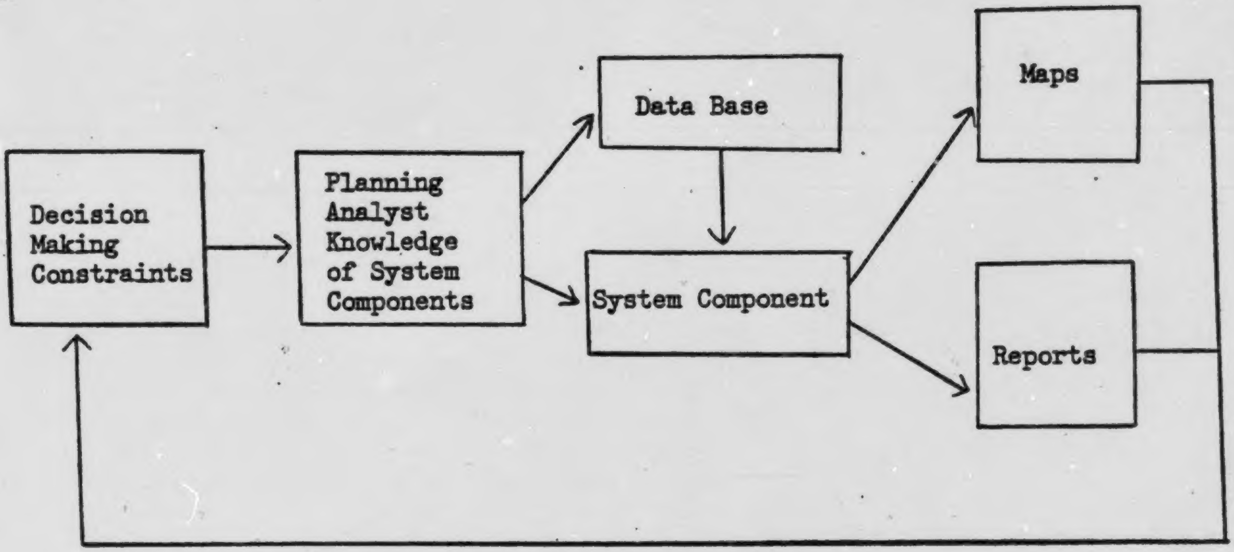
Each of the agencies involved in the project should recognize the limits of their involvement in the effort, and not expect more from the project than is practical. The Clark County School District must realize that the project development will cause delays beyond the required court deadlines for redistricting. The tasks to be accomplished by the project should be further defined to prevent efforts from being diverted from the original project goal of providing a practical school districting system to local school planners. The additional definition of the steps required in developing the project should be reviewed by the technical advisory committee in order to establish concurrence on the timetable for the system development.

Problem Definition

Defining the scope of the school districting problem is critical. This definition must consider the practical needs of school administrators throughout the country. A bias toward readily available technology must, by necessity, influence the definition of the problem but the limits of available technology should not be allowed to restrict the scope of the study in ways that limit the useful output of the project. The simplifying assumptions associated with most readily available technology and the easiest to understand theoretical solutions to the districting problem prevent the development of a really useful approach. Because the definition of the school zoning problem is so critical to developing useful techniques, these assumptions are to be reviewed by experts in NIE and local school administrations during this feasibility study. Prior to implementing any steps of the proposed solution, there must be concurrence on the scope and direction of all technical effort.

In practice, the school zone problem extends beyond technical considerations of data and programs, since it must be solved within the context of local government decisionmaking mechanisms. Factors like the financial aspects of school budgeting, which are complex and require the trade off between capital and operating expenses, must also be considered. In addition, public relations efforts must be considered since most political processes must work with the conflicting desires of public groups who seek solutions favorable to their particular interests. Thus, the practical school problem must be seen in an organizational and political context which require administrators and planners to trade off factors which are not included in the technical description outlined above.

The school location boundary problem is complex. The problem involves a series of related technical issues and component problems. Much of the problem is related to the type of organization which is established to locate schools--especially its relationship to local political structure. Solutions frequently involve the insights of local decision makers which cannot be articulated in a technical context. Consequently, results which are obtained by using theoretical optima, that is, without the involvement of local administrators to modify the results, are usually considered impractical. Therefore, tools which help the administrator, planner or decisionmaker work with the technical complexities of the school location problem within the local political and organizational environment are necessary.


Decision Making Constraints
Planning Analyst Knowledge of System Components
Data Base
System Component
Maps
Reports

Problem Solving Environment and Principal Technical Components

Data and Policy Issues

Many political and administrative decisions must be made during the search for solutions to the immediate problem of selecting a school site or a set of appropriate boundaries for a proposed zone. Frequently, incremental decisions preclude alternatives and direct the decisionmaker toward a particular viewpoint. While many of the factors that must be considered cannot be quantified, they must be included in the analysis. The complexity of the problem that is faced by the school planner should not be underestimated.

The following pages attempt to outline the data and policy issues which must be considered by a planner in locating a school's boundaries. These issues are separated into four lists which overlap and interrelate. Issues are grouped in terms relating to student location, school zoning, student transportation and population projection. Since these lists are an attempt to show that the scope of school boundary problems are broad, additions to the lists would be welcomed.

Items on these lists are grouped in similar related categories. Each data item can, in turn, be related to policy decisions. In order to prevent the exclusion of particular policy alternatives, all data relevant to school planning should be included in these lists. Each data item must then be related to policy issues to be supported by the system design. The actual direction of policy must be left entirely up to local school decisionmakers.

A. Student Characteristics

The following factors relate student characteristics and location to the school assignment problem:

1. Age and grade level of child
2. Special program or facility needs for handicapped, or other special groups
3. Emotional or interpersonal problems among individuals or groups
4. Number of children in family
5. Racial and economic balance in neighborhoods and schools
6. Educational attainment of families in area
7. Health hazards (student safety in area or traveling through an area)
8. Road network (special access, approaches or width)
9. Land use information (retail stores or bars/restaurants/liquor stores)
10. Rural area location problems such as house numbers
11. Physical boundaries (rivers, cliffs, etc.) which restrict transportation
12. Neigborhood traditions
13. Neighborhood organizations
14. School facility locations and their relation to other physical factors
15. Financial capacity of locality, town or general school area
16. Areal units used for clustering in school districts analysis

B. School Zoning

School zoning data is concerned mainly with the manner in which the school plant or facility itself is or can be used. Critical zoning issues focus on facility use in relation to a variety of other factors. As such, educational policy issues are heavily involved but resource use and financial policy dominate many related concerns.

1. Type of special curricula at each facility
2. Special program eligibility for federal dollars
3. Enrollment with school population characteristics
4. Racial or economic integration (desired or court ordered)
5. Neighborhood usage for community functions to support cost
6. Neighborhood school concept
7. Determination of eligibility for school activities
8. Changes in community growth
9. Grades served by a particular facility
10. Capacity by grade, classroom or other facility
11. Time of day school is scheduled to be used by an activity which includes split sessions or outside use of facility
12. Months in which school facility is opened including year round school scheduling
13. Changing standards and requirements of school facilities
14. Desired utilization rate, maximum utilization rate
15. Age and quality of school plant
16. Special resources use like rooms for audio visual, education, athletic scheduling, mobile classrooms
17. Teacher assignments, temporary and permanent unions, recruiting and special demands
18. Pupil-teacher ratio
19. School grade transfer and promotion policies for students, teachers
20. Location of administrative offices

21. Supply vehicle access to schools
22. Emergency vehicle access to schools
23. Student/teacher access to facility (distance and convenience)
24. Dangerous locations in vicinity (railroad, high crime, etc.) safety
25. Environmental (noise, smoke, etc. other problem) aspects
26. Land purchase--land bank, immediate need, expand current facilities, land sale
27. Site development cost
28. Site developments needed
29. Construction, renovation and maintenance costs
30. Construction or demolition scheduling
31. Property valuation
32. Financial models for bonding, borrowing and donations
33. Capital versus operating expense
34. Public relation-use of maps and school descriptions
35. Political concensuses issues (special citizen desires or public pressure)

C. Transportation

Transportation data are important in linking the location of students to the facilities they are assigned to attend. Transportation issues involve both economic savings and quite complex policy problems when linked with busing for racial or ethnic balance.

1. Grades to be bused and age mix per bus
2. Transportation of handicapped
3. Link busing to school schedule or special events
4. Deciding the area for busing and type of buses to be used
5. Legislative restrictions (busing to 2nd closest school)
6. Estimate costs of expanding service to new areas
7. Limits on reorganization of routes through unions or other local factors (maximum stops per route, maximum run, driver availability)
8. Road characteristics such as safety, time distance, traffic, condition railroad crossings, bridges, private roads, expressways, deadends, inventoried
9. Locating bus stops (mid block, protected, safety, access, number)
10. Impact of physical and natural features on route patterns
11. Use of public transportation (mixture cost of passes) for partial support
12. Shortest and fastest route developed (minimizes time, distance)
13. Equalize bus wear and tear through regular use pattern and regular maintenance scheduling (vehicle condition reporting)
14. Loading and unloading minimized versus convenience and safety of children
15. Minimize travel of empty buses
16. Starting and finishing times for routes
17. Maximum allowable time on bus per student
18. Racial composition of those to be bussed.

D. Population Projection

Population projections are important in predicting the use of school facilities and transportation resources. Changes in land use and population growth in particular groups may also have important implications for the development of road networks, housing projects, or other government facilities which in turn influence the school facility plan.

1. Social and economic characteristics of the area's population.
2. Changes in area definitions or city boundaries
3. Private school population
4. Special population characteristics (handicapped, special programs).
5. Migration data which points to areas of population change using building permits, telephone installations, sewer permits, and utility information
6. Student characteristics, such as age, grade, race, sex, income, poverty, family employment characteristics, residence, and type of dwelling unit
7. Business trends projection for training and employment projections
8. Population to be bussed
9. Population mix in schools
10. Neighborhood development - boundary criteria
11. Population making choices for particular schools

Technical Approach

The technical approach to be used in developing practical districting alternatives for school planners requires the integration of the work of several agencies who have developed computer programs to solve parts of the school boundary location problem. This approach allows us to consider the districting problem modularly, i.e., as several distinct sub-projects which can be undertaken and used independently. This modular approach depends on exploiting programs which solve limited sections of the problem. Much of the development work in these programs is done, but work still remains in linking these programs together. Some of these programs were developed without practical testing in the field or without evaluation of their effectiveness in real location problems.

Modular approach is judged to be feasible at the present time. At the start of the project, however, the total systems view should dominate the planning of the project.

The solution to districting problems is formulated as a system with six parts and an overall control monitor which allows the user to address and work within the limited approaches taken by the parts. The first part is the student location component which allows for the identification of all students at their place of residence with information on relevant street network and school facilities data. The second part is the site evaluation model which will allow the planner to analyze the educational, financial, health, safety and political aspect of each proposed site. The third part is an interactive assignment component which allows the planner to draw districts and evaluate them using educational policy criteria. A fourth component allows the planner to generate the same alternatives and evaluations on a completely automated basis. The fifth part allows for the computer assisted development of busing routes and transportation alternatives. The sixth part is the population projection component which permits the pupil location and assignment sections to be evaluated in terms of plans for future school uses.

Program Components

The student locating subsystem is a set of programs which creates a reliable geographic base file and matches school attendance records against that file in order to assign geographic identifiers to students to be used in the planning support system. The programs and files to be used (GBF/DIME, UNIMATCH) were developed by the Bureau of the Census and are currently operating in the major metropolitan areas of the country.

The site evaluation subsystem is a program which will create a basic report on the physical qualities and financial requirements of each site. Costs of expansion or contraction of building potential and maintenance will be recorded. Current and potential maximum of classroom and other educational facilities at each site will be involved in this report. Although prototypes of this subsystem exist, they do not meet the specific needs of a practical, local reporting system.

A school zoning subsystem would use a set of programs to assist the school planner in evaluating alternative school district plans or attendance areas based on the concept of neighborhood areas to be served by each school. The school planner can thus test the results of his plans and evaluate them in terms of education policy, teacher assignment, or other components of facility use.

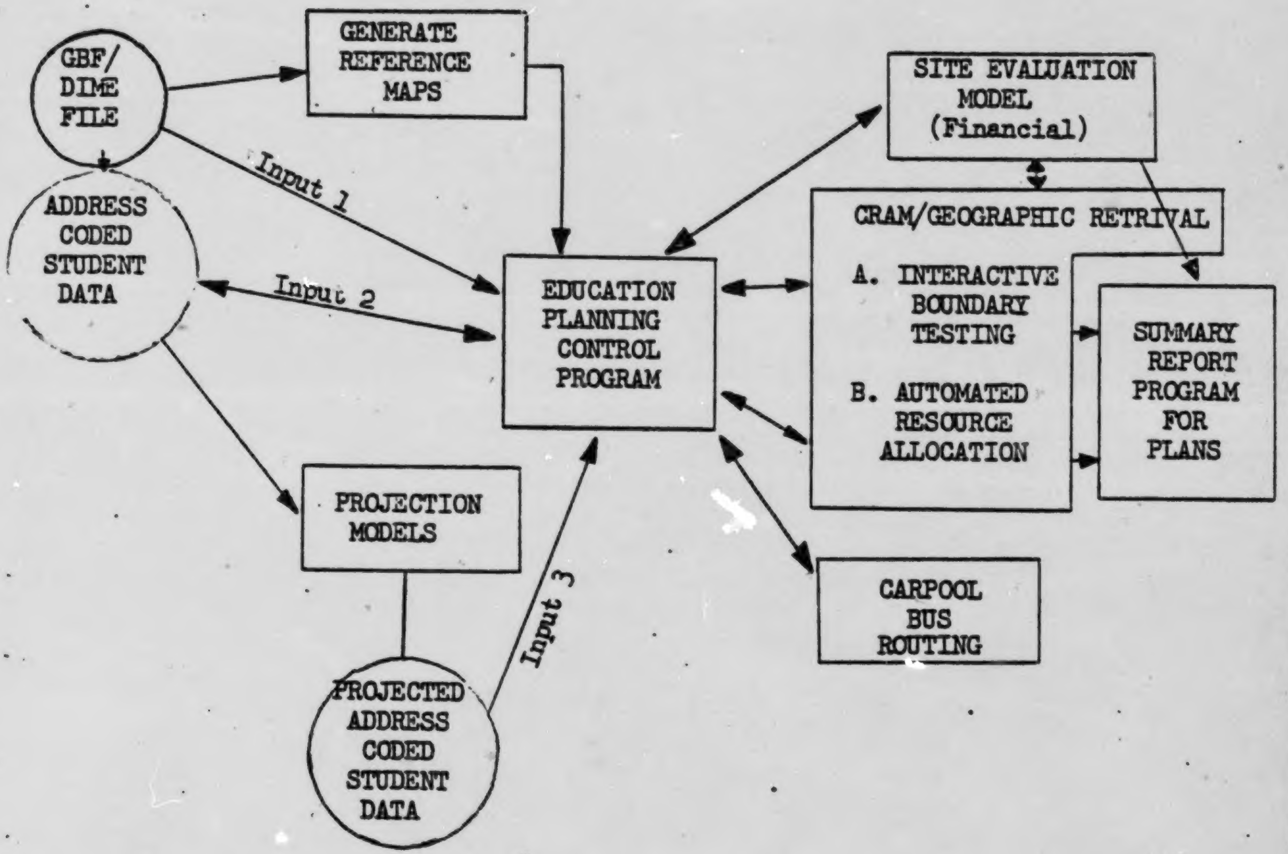
The development of this subsystem is dependent on the development of the student locating subsystem and the specialization of several generalized automated site evaluation and facility assignment programs for this task. Some of the programs to be used in this subsystem have been developed by the Census Bureau to solve resource allocation problems, for example, Computer Resource allocation Model. The interactive version of this subsystem is yet to be developed.

The student transportation subsystem is a set of programs which will permit the examination of transportation alternatives in conjunction with the school zoning system. This subsystem must work in conjunction with the previous two subsystems and provide a means to examine the current impact of the total student and school facility assignment processing. One program to be evaluated for this application is based on the (CARPOL) program developed at the Bureau of the Census.

The student population projection subsystem will allow for an estimate of the future impact of the student and school facility assignment procedure. This subsystem can work independently of the previous two subsystems but will depend on the development of the student locating subsystem. The resulting projections from this component will feed back into the school financial and student transportation subsystems. The programs to be developed for this subsystem are based in part upon small area population estimating techniques which were tested in Los Angeles by the Census Use Study and in part the application of other population estimating techniques which are traditionally used in school enrollment projections.

These six subsystems will be designed to work together and provide the nucleus of a generalized education planning support system. Many of the procedures involved and many of the basic programming techniques to be used have been developed and tested independently. This project will further develop and integrate this material into a system for assisting facility planning.

Figure II: Proposed Solution Components


GBF/
DIME
FILE
GENERATE
REFERENCE
MAPS
ADDRESS
CODED
STUDENT
DATA
Input 1
Input 2
EDUCATION
PLANNING
CONTROL
PROGRAM
SITE EVALUATION
MODEL
(Financial)
CRAM/GEOGRAPHIC RETRIVAL
A. INTERACTIVE
BOUNDARY
TESTING
B. AUTOMATED
RESOURCE
ALLOCATION
SUMMARY
REPORT
PROGRAM
FOR
PLANS
PROJECTION
MODELS
Input 3
PROJECTED
ADDRESS
CODED
STUDENT
DATA
CARPOOL
BUS
ROUTING

Problem	Computer Program	Status	Cost
GBF Construction	GBF/DIME Edits	Operational	Assumed by Clark County
Address Coding of Student Locations	UNIMATCH	Operational	Assumed by Clark County
Student/Facility Mapping	GRIDS	Operational/Needs Modification	$30,000
Interactive School Boundary Manipulation	CORET	Needs Programming	$80,000
Evaluation of Transportation Routes	CARPOL	Operational Needs Modification	$60,000
Generation of Transportation Routes		Needs Programming	$80,000
Financial Analysis		Needs Programming	$40,000
School Population			
Estimation (A)	MULTIPLE - ETA	Operational Needs Modification	$50,000
Projection (B)		Needs Programming	$50,000
School Location Evaluation Summary Data Report		Needs Programming	$30,000
Control System Executive Review		Needs Programming	$30,000
		TOTAL	$510,000

Cost - Benefit Summary

In order to estimate the value of the proposed system, rough calculations of both the costs and the benefits resulting from this work is outlined. The benefits over costs for this single locality are estimated to be about 5 to 1. These calculations are, of necessity, rough measures, but the conclusion of the usefulness of the project is inescapable. Further, it is precisely this preproject analysis which can form the basis of the evaluation of the output of the end of the project.

A. Cost

The cost of developing a full school boundary location planning system is estimated at $510,000. This cost is exclusive of the cost of developing the Census base file material which are required for the operation of such a school location system. The total cost of developing the system can be justified in its potential use by a large number of school districts throughout the nation who have access to the Census base file material. If an estimated 1,000 school districts which have access to the base file material use the application package, a development cost of approximately $500 per school district is calculated.

In the context of the wide-spread use of the school location evaluation package, the start up costs must be carried by the local school district using the package. For a school district the size of Clark County, this cost may be as much as $100,000. For this investment, though, such a local school district can obtain an immediate first year return of between $400,000 to $500,000 in costs saved. The result in the first year would be a benefit of more than four times the original cost. Because of this high cost as the original development site, Clark County will require either local or Federal funding to support the expenditure which will result in the development of a national user package.

B. Benefit

The use of an education facility planning support system can have many benefits to users. Some of these benefits are related to the convenience and well-being of students, teachers and school staff. While these benefits may be as important as financial benefits, they cannot easily be quantified and thus they are only noted as being significant and not fully integrated into the following analysis of project benefits. The benefits that are listed in the following pages are conservative estimates of the quantifiable benefits of a planning support system in Clark County. At the end of the successful implementation of the system in Clark County, the benefits will be recalculated for a further evaluation of the transferability of the system.

The benefits of an automated system for education planning fall into four categories: the establishment of efficient school zones; the evaluation of approximate school sites; the establishment of efficient bus routes and finally the example set in the use of technology for other agencies in the county. After a discussion of these general categories of benefits, a chart showing the amount of savings associated with each subcategory is presented.

In the area of school site evaluation, the following benefits can accrue to counties using the automated school planning techniques:

- Effective utilization of current sites by filling school plants to an acceptable capacity and delaying capital costs for additional schools.

- Effective planning or contraction the early identification of school sites for proposed expansion and investment in site improvements when least expensive. Fewer emergency changes should result and planned changes should allow for the more efficient use of currently operated sites. Efficient distribution and allocation of supplies by better supply delivery which eliminate waste.

- Effective land purchase or site inventory programs considering need, tax loss and increase in land values to assure that the district is neither in a position of holding too much land for school sites or required to purchase land at a premium during times of heavy demand.

- Selection of sites for construction or closure which inter-relate efficiently with other needs—transportation, land use, capital value and planned residential/industrial/commercial development needs. This interaction thereby increases the value of the educational site to the student and total county environment through consideration for such specific factors as decreased accidnets or increased emergency vehicle access and increased relevance of educational programs.

In the area of school zone establishment the following benefits can be itemized:

- Efficient use of the time of school planners in setting up district plans and adjusting districts to meet the criteria established by the school board. Savings of directly related personnel costs can be made as well as indirect costs incurred by the delays inherent in the way manual system solutions are developed.

- Decreased cost and time in searching for alternatives to meet court-ordered requirements for racial mix in schools and classrooms. In addition to attorney costs and administrators costs incurred by delays and disputes resulting from incomplete data, the automated system can produce output which can be used for presentations and public relations material for the plan alternatives.

- Decrease in costs associated with changes in facility allocations and issuance of new plans made necessary by community growth. Moving costs, un-ordered materials, loss of materials, as well as loss of personnel time by frequent moves should be calculated in this benefit. Decreased costs incurred by the disruption of routine procedures may also be included when changes in curriculum and other school activities provide a more constructive dynamic environment within which the school staff works. While moves of this type may be a stimulant to the staff of the schools, more constructive use of these changes is possible when non-beneficial changes are minimized.

- Increased funding from Federal support programs is possible in cases where students with a particular need can be grouped together for the efficient use of resources. Planning for standard programs for handicapped, poverty area or special learning disability students can be improved when such students are grouped. Furthermore, by the appropriate grouping of those students, new programs may be devised and funded as experimental learning programs.

- Increased access to facilities and more reliable communications among staff are possible with better planning of these facilities and the establishment of a stable education environment. Costs of materials delivered from warehouses, routing of services for facilities, and the convenient location of an administrative center which can monitor the operations of the school district.

In the establishment of improved bus routes, the following types of benefits can be identified:

- Substantial savings in fuel costs for the school district can result if a minimum path objective is selected in the design of more efficient bus routes. A total minimization of costs as an objective may not yield practical bus routes, but substantial savings can be expected from adoption of even a sub-optimal plan.

- The loading of buses closer to maximum capacity is made possible through computer scheduling since routing is made easier. The reserve capacity needed for growth during a year can be reduced since bus loadings can be done closer to the opening of the new school year. Thus, computer scheduling results in greater utilization and lower costs over existing manual approaches which require greater lead times and hence larger reserve capacities for growth.

- A variety of acceptable alternatives can be developed for study by a school district under a court injunction to redistrict to achieve a better racial balance. The development of district plans acceptable to local groups is difficult. The development of district plans acceptable to local groups is difficult. The imposition of an additional authority to determine the acceptability of district plans further increases the difficulty of preparation. The proposed system provides the practical benefit of alternative plans which show the effect of a variety of considerations to be discussed with public groups.

- Current public transportation can be included as an optional alternative means of school busing for additional cost savings. Such use has had significant payoff in many cities. By using public authority buses or private buses in non-peak hours, operational costs can be minimized. The use of the local bus system (or any public transportation system) as an integral part of the bus plan can save both planning and operating cost for those populations involved.

- Management of the entire transportation operation will be made easier since data concerning bus routes, facilities, equipment and manpower will be prepared by the system. Better management, in turn, should generate further efficiency in the control of expenditures. For example, personnel costs would be decreased through reduced overtime and better maintenance schedules.

The fourth general area of savings to the country comes from the use of the data base and associated school location technology by other agencies in the country.

- Project prepared materials can help to clarify other educational issues for decisionmakers in both professional/educational staff positions and in political positions. The use of this material to show the benefits of education policy alternatives on the school population and the community is of great value to the community leadership who must justify their decisions to the public and to other professionals.

- The prepared materials can be modified and used by other local governmental agencies in helping them to make siting, zoning or routing decisions. While additional costs would be incurred in converting from school location procedures to other site locations problems, these costs would be for less than if each agency had to develop its own technology from scratch.

- The experience of using the systems provided by project should show the usefulness of cooperative ventures in data exchange among county agencies. This cooperative data exchange will help each county agency get access to data they would otherwise have to collect themselves. The project will yield substantial benefits through the standardization of data formats.

- Having adequate data on facilities and the use of these facilities should enable school planners and administrators to shift schedules and facility usage to decrease total energy costs (lighting and heating). If the energy continues to be in short supply, these data may be used in testing alternatives for reducing the impact.

Exhibit I: Estimated Benefits

Benefits	Immediate Cost Saving		Deferred Capital Costs	Non-Quantifiable Cost Saving
	School District	Other County		
School Zone Establishment				
- Efficient Development of Plans	20K			
- Alternating Plan Development in Face of Court Order	20K	20K		
- Consideration of Community Growth (Fewer changes)	20K			
- Increase in Federal Support	10K			
- Increase Access/Communications		10K		
School Site Evaluation				
- Effective Use of Current Sites (Capital cost delay)	50K		500K	
- Early Identification of Improvements (Fewer emergency changes)	50K			
- Distribution of Supplies	20K			
- Land Purchase/Inventory	10K		100K	
- Reduced Site Costs Due to Overall Integration and Other Factors	50K			
- Emergency Access				Lives
Bus Route Establishment				
- Save Cost on Energy	20K			
- Increase Safety				Lives
- Alternative Development in Face of Court Order	10K	10K		
- Plan Overlap with Public Transportation	10K			
- Cost Control/Maintenance of Buses	10K			
Use of Technology by Other Agencies				
- Use to Clarify Educational Issues in Political Environment	50K			
- Use by Other Departments in Siting Administration		50K		
- Expand Data Exchange	10K	50K		
- Energy Saving in Facility	3K			
	363K	140K	600K	Lives

The trade off of using capital funding in school plant construction instead of operating expenditures for transportation is dependent on political and financial considerations within the area involved in implementing the automated school planning system. Likewise, the advantage of long range view over the short term view regarding a capital investment must also be considered in a local area context. In order to quantify final benefits to Clark County as the development site or any transfer site, all measures will have to be discussed and modified according to the local view of the benefits derived from implementing the educational facility planning support system.

Additional benefits which relate to increased safety, security and other non-quantifiable variables should also be considered. These effects increase the benefits above those that can be easily quantified, and they should be recognized in evaluating the final impact of the school location system.

Summary Cost-Benefit

Original Cost for Development	$610,000
Contribution by Clark County	100,000
Needed for Development	510,000
Benefits to Clark County	503,000
Benefits to other County (not court-ordered integration)	440,000
Benefit to cost ratio for Clark County	5.3 to 1
Benefit to cost ratio for other Counties assuming $100,000 contribution cost	4.4 to 1

Conclusion

This study has examined the feasibility of developing a computer-assisted school boundary location, planning, student allocation and busing system at the local level. The conclusion is that the materials, tools and methods developed at the Bureau of the Census do provide a base for the development of a fully comprehensive system for school planning. The materials developed at the Census Bureau are quite essential, but modification and tailoring of some programs together into a system must still be developed.

In order to determine the feasibility of developing a practical set of tools to solve local school zoning problems it has been necessary to design a basic approach to the problem of school boundary location analysis and outline a series of steps to be followed in developing this set of tools. The series of steps are combined to yield procedures which can be used independently to assist the school planner but which when joined together can support the full range of school zoning decisions. Each set of tools can be evaluated independently and each tool, by itself, can be shown to have significant benefit in areas where the basic Census geographic files are currently in use.

The most costly component on the project is the population projection component. This part of the project is important in providing the planner with data that he has not been able to obtain in his usual analysis. This section of the project is the part, however, in which most research into methodology has to be done and in which alternatives to current Census Use Study methodology may be required. As important as it is, this section can be separated and created independently if such population projection procedures are not considered critical in this first application.

The primary conclusion of this study is that such a development project is feasible in Las Vegas because local planners have invested so much time and resources in building a reliable geographic base file through the GBF/DIME System. The task of developing the facility information will be complex and costly. Uncertainties are present but the project should have useful tools being developed during the period from June 1975 to December 1976. The total system development cost is estimated at $510,000. Since the project is comprehensive in scope but can be planned based on its component parts, delays in development and increased costs of components can be determined early and identified readily.

On a technical level, several conclusions are important. None of the currently available computer programs completely satisfy the needs of the school planner. While the CRAM and CARPOL from the Bureau of the Census satisfy certain basic needs, they must be modified in order to achieve the necessary specificity required by the best school planners. However, modification to the basic structure of the GBF/DIME File and the Address Matching system is not necessary. In other words, the basic resource tools for building the system are available to the project without modifications.

Data collection is necessary, but data linking and geographic identification has already been accomplished in Las Vegas—a significant beginning for the test development.

The output of the project will meet the needs of local planners. In the first year, the time and money saved in developing the school district plans and transportation routes by computer will pay for the transfer costs of this technology in most cities. The increased flexibility for planning represents a benefit which is not easily quantified but is essential to those who must react quickly to public pressure and local needs. On the basis of the full benefit calculation for the application, local areas should receive a benefit well over four times the cost of transfer.

PART III: APPENDICES

I. CRITERIA FOR LOCAL INVOLVEMENT

II. TECHNICAL APPROACH

  1. Geocoding

  2. District and Bus Route Formulation

  3. Population Projection

III. ESTIMATED MAN MONTHS OF EFFORT

IV. PROJECT SCHEDULE

V. PAST APPROACHES

VI. BIBLIOGRAPHY

VII. GLOSSARY

I. Criteria for Local Involvement

This report suggests for the development and testing of school location procedures in Clark County, Nevada. Clark County has completed the steps required to get the first subsystem (GBF/DIME) operating within the City of Las Vegas and the county limits. Upon completion of the successful testing of the school boundary location system in Las Vegas, a transfer site can be selected for further testing of the materials that were developed for Clark County. This transfer site should be a major urban area with special school problems (New York, Los Angeles, Miami, or similar major urban areas) but need not be selected until the project is well developed in Nevada. Funding agencies may require, however, that the transfer site have completed work on some parts of the student location subsystem before the technology transfer is begun.

Clark County, Nevada can be recommended as the site for the further development of the school location procedure for three reasons: the area is struggling with typical school zoning problems; there is strong local interest in developing such a procedure and there exists local technical expertise in working with geocoded data.

Clark County must cope with many school planning problems typical of local areas. The area is beset with the problem of central city deterioration combined with suburban growth. There are several areas in Las Vegas which are transitional neighborhoods but, more important, there is rapid change in the composition of neighborhoods because of a high turnover of population. The area is a recipient of many standard federal funds through PL 874 and local planners have been faced with the potential of year round school/double sessions and emergency building programs. Because of many factors inherent in the growth and physical structure of Las Vegas, the area combines typical urban suburban and rural school location problems in one location.

The Clark County school district, like most districts in the county, is frequently faced with the problem of developing new school policies which relate to the use of school facilities. Currently there is a need for the development of a district-wide policy on school lunch programs. Policy considerations include the use of facilities, increased local costs, potential federal support and the interrelationship of school data with other local data to determine the magnitude of the problem (such as, relating poverty families with children to school districts).

Clark County representatives visited the Census Bureau and requested help in the use of their own school data with data analysis methods developed at the Bureau. Local activities were accelerated in order to meet the requirements of a Federal court order to redistrict local schools to obtain a better racial and ethnic balance. The school planners in Las Vegas, working in a rapidly changing community, wanted to develop a method to prepare alternative plans rather than a single plan which might satisfy the immediate need. The planners, through experience in working with large map projection of school populations, were aware that for the past several

47

years parts of their community had been growing at an alarming rate which required the building of two new schools per year. The Clark County school district planners, considering the local effort that had been put into school planning, indicated that their specialized personnel would help to develop a prototype redistricting system which could be used elsewhere in the country.

Over the past several years the Clark County school planners have been developing and adding corrections to the Census Bureau GBF/DIME files. In addition, the Police, Fire and Highway Departments in Clark County have committed resources in order to include in that file all changes in the street network. Plans are in progress for coordinating the use of the school and base file data with other agencies such as the County Data Processing Department, the Regional Planning Department of the Clark County Area, the County Police and Fire Departments. A combined responsibility for maintaining the file will ensure the high quality of the base file around which the school location application can be built.

The base file was recently updated. The total file correction process took 9 months with student labor after preliminary tests indicated that the 1970 file version contained many errors. School planners in Clark County have been using the DIME file for address matching of student locations on the computer belonging to the County School Department since 1973.

The first ADMATCH involved 77,000 records and reflected a 12% mismatch. A subsequent ADMATCH using the improved base file achieved a 98% match rate. The initial ADMATCH was for students in grades 7 through 12. This matching allowed the zoning department of the school district to complete the projected number of students for zoning for the 1974-1975 school year. The school district was then able to zone students on the secondary level, junior high and high school, to a degree of accuracy never before achieved by the planners.

At the present time the school planners have a system of mapping in the zoning and planning office which uses eight - 4'x8' displays. Two displays show the Metropolitan Map Series from the Census Bureau with elementary school zones color-coded to indicate the exact tract number, school number, and street intersection nodes. At any given time, a staff member can identify given points relative to school geography. With these points, current data on students in a geographical zone can be obtained. Two more displays are available for the junior high school zones and two more displays for the high school zones. Two additional displays which are a one-half reduction of the Metropolitan Maps pieced together into one map indicate elementary and high school zones using different color-codes. These last displays give an overview of the three zone boundaries in the three grade levels.

After the development project is begun, a second test site is suggested to show how the technology developed under this project can be transferred to solve districting problems in other counties. The transfer site is designated to be not only a test of the programs and the methods of the project but also as test of the educational and training materials developed to accompany the program package used in the Clark County test.

While the secondary site need not be named for several months, three sites have been proposed which represent a significant departure from the Clark County situation - Los Angeles County, California; Kings County, New York and Broward County, Florida. The final selection of the transfer site should be made depending upon the amount of local support that is available for the project as well as other educational policy criteria. Many school districts have expressed an interest in using the technology that is developed and certainly many school districts have problems related to school districting.

The three transfer sites are suggested because the staff preparing this report have been in contact with local school representatives from all three areas. All of these areas have expressed an interest in using the school planning tools, have trained professionals available who know the GBF/DIME techniques that are required, and have an immediate need for the programs being developed by the project in solving school location problems.

II. Technical Approach

1. Geocoding

Geocoding is the process of attaching relevant geographic codes to data which have less useful geographic codes. Usually this means converting street address to some area code, e.g., census tract or school districts, but may involve more complicated conversion, such as from street intersections to bus route.

A wealth of data useful for planners is scattered among existing files, e.g., Assessor's files, welfare files, school files and motor vehicle registrations. Accessing these data is often difficult or impossible due to lack of compatible geographic codes, confidentiality rules, etc. A planner can often surmount these barriers through geocoding.

As agency responsible for confidential information about individuals may be willing to release summaries of these data by some geographic area. For example, census data on individuals is confidential, but tabulations by block, block group, census tract and other geographic areas are released through aggregation. Student rosters have been successfully geocoded in several cities and have been reported on a small area basis.

Often an agency will prepare and release tabulations of data by a geographic area important only to itself and not important to other users. For example, school administrators need tabulations by school district, which probably do not conform to other statistical or planning zones. As a further complication, school district boundaries change from year to year and this destroys historical continuity and renders analysis by other zones prohibitively expensive. However, provided the street address is available, geocoding solves these problems by allowing for comparability at the address level.

A. Geocoding can be accomplished by either of the two following computer programs:

ADMATCH - ADMATCH was designed to assign geocodes, like census tract, to street address. ADMATCH operates by linking two logically connected files: a data file and a reference file. The data file must contain a street address while the reference file contains both the street address ranges and the corresponding geocodes. ADMATCH performs this file linkage in two phases. The Preprocessor analyzes a character string address according to syntax and keywords specified by the user and creates a standardized version of the address called the "match key". The Matcher compares the data record match key to all the reference file records with the same street name and selects the best match. The best match is determined according to a weighting scheme determined by the user. This program can be used to code student addresses to test school district boundaries or to census areas for population projection.

UNIMATCH - The applications for file linkage are so extensive that Census Bureau developed a generalized file linkage system called UNIMATCH. UNIMATCH is similar to ADMATCH in that it consists of a standardizer and a matcher. However, UNIMATCH is not limited to matching street address. Instead, street intersections, major traffic generators or any logical connection may serve to link two files. This generality is achieved by allowing the user to specify the fields to compare, the comparisons to make (e.g., character, numeric or parity comparisons), the weight to attach to a success or failure to compare and finally the action to take depending on the level of success of the comparison. That action might be further comparisons or the copying of selected fields from one to another. This program can be used to match students to bus-stops, bus-route links or other facility locations for bus-routing or school assignment.

The reference file typically used for address matching by UNIMATCH is called a Geographic Base File (GBF). Since urban planning is so extensively related to geography, attention should be paid to GBF's and their multitude of applications. A GBF can be defined minimally as a correspondence table for two or more geographic codes. However, a GBF may be much more complicated, viz., it may relect any geographic related structure of information. For example, street network and land use information may be contained in a sufficiently finely resolved GBF.

There are basically two kinds of geographic base files:

ACG - The Address Coding Guide (ACG) is a GBF in wide-spread use. Each record in the ACG represents one block face and contains address range information and geocodes like census tract, county and place. The ACG was developed by the Bureau of the Census to facilitate the mail-out mail-in census. The Metropolitan Map Series (MMS), which serves as a source for ACG coding, was the first step in standardization on a nationwide basis.

Those maps were produced by the Census Bureau for each standard Metropolitan Statistical Area (SMSA) in the United States.

GBF/DIME - The Dual Independent Map Encoding (DIME) file is a more complete type of GBF. The GBF/DIME concept was developed and first implemented at the Census Use Study. Each record in the DIME file represents a street segment bounded by a node at each end. Nodes are placed on a map (Metropolitan Map Series) at various points, i.e., each street intersection, each intersection of a street with an important nonstreet feature like railroad crossings, and along curves. Furthermore, the DIME file contains the geographic grid coordinates of each node. The node and coordinate information renders the DIME file useful in mapping, routing and geographic retrieval applications

2. District and Bus Route Formulation

Past approaches to bus routing were based on hand coded networks but now the GBF/DIME file can be used to eliminate this initial effort. However existing software may have to be modified to take full advantage of the GBF/DIME files capabilities. The existing programs of the Census Bureau are advanced, but the attempt to adapt these programs to the school district and bus route problem will involve additional work. When possible, of course, generalized and existing programs will be produced so that the developed software may be used for other related planning problems.

Given the ability to code student data to a topologically correct description of the street network, the user can work with several approaches. For instance, because of the assigned coordinates, a simple geometric radius from a point can be used to circumscribe an area. The geocoded data can then be selectively aggregated to represent the enclosed area. Another approach, rather than treating airline distance, would be to aggregate the linear segments to represent distances (or time or costs spent traversing) from a point on a network as a car moves or to calculate cumulative distances for students in a school district.

The first approach to solving this problem is to use an interactive retrieval program CORET

CORET - Coordinate retrieval allows for the retrieval of geographically coded population units by specifying the boundaries of a geographic area to be examined. The population units to be retrieved must have coordinates (latitude and longitude) assigned to them and must be contained in a common data base. A report can then be compiled from the data that is retrieved from the data base. This report is then displayed in a form appropriate for the school planning application. In past applications, the population unit most used has been U.S. Census blocks or enumeration districts but both block data and student address data can be used.

In operating the coordinate retrieval routine, the user communicates to a main computer center via a remote digitizer terminal which transmits X and Y coordinates of points on a map mounted on it. The digitizer terminal which includes alphabetic keyboard entry, communicates to the computer through ordinary telephone lines, and may be located whereever convenient to the decisionmaker. By using coordinate retrieval with a digitizer terminal, single points of data, data which are a specified distance from a point, and data within described boundaries can be summarized and analyzed. Operating the coordinate retrieval program requires that the user have access to a data base in which an X and Y coordinates are assigned to each data element.

Upon receiving a request to evaluate an area, the computer proceeds through the list of population units to determine those that lie within the boundaries of the described area. Whenever a population unit is determined to lie within the area requested, that unit's total population characteristics are added to the area totals.

The computer analyzes the aggregated area statistics and subgroup data and then prints out report of characteristics for the areas described. Using this system, other specialized reports could be designed and written to be used in particular applications.

In addition to the use of this coordinate retrieval methodology, the CRAM model can be used for a network search in order to formulate district boundaries.

CRAM - The Computerized Resource Allocation Model is a sophisticated application of DIME file technology. Basically, CRAM is an automated system for determining the service area boundaries for a set of facility locations.

The system uses a DIME file as its network base and, in addition, requires inputs of demand and facility capacity. The problems which can be attacked through CRAM range from simple fixed source districting problems, such as school district boundaries, park planning, and site location to much more complicated problems of emergency vehicle routing, delivery or bus route planning and freeway location studies.

CRAM uses a modified version of the Moore Shortest Path Algorithm to do its geographic analysis. The Moore technique finds shortest paths between points using a point-to-point incidence matrix (with associated distances or costs) as its "road map". In this technique, the network is viewed as a set of interconnected nodes, the connections being links. The DIME file, however, directly represents a set of interconnected links, the connections being nodes, and therefore can be used in the allocation of demand.

Demand on a facility is generally the number of persons desiring to use the facility. Information about numbers of persons usually relates to blocks or block groups - not nodes. However, the disaggregation of persons to links is more reliable than disaggregation to nodes since links have length. As a result the disaggregation may be varied according to length, and therefore persons associated with the GBF/DIME links can be allocated using CRAM.

In its current form, CRAM can be easily modified for use in the district boundary problem but not for the bus routing task. Therefore, a new program must be written, using the same basic algorithm but generalized for use in various path-type problems based on the DIME file, including the bus routing problem. This new approach returns to network analysis after assigning students to bus stop domains using the CARPOL Program.

CARPOL - CARPOL is a computer program designed to provide a workable, economic means of producing lists of potential fellow-riders for participation in carpooling programs. The lists generated, however, would not assign students to particular buses. Rather, their aim is to provide each student with an association to a bus-stop and then the bus-stops are collected into making a bus route.

A list is created for each potential bus-stop of students who have met geographic and non-geographic criteria for aggregation. The geographic criteria are:

1. The minimum and maximum number of students desired at each stop
2. The maximum distance students can walk to a bus stop

The non-geographic criteria are:

1. Common school days
2. Common school hours
3. Participation in after school activities

Specifically, the CARPOL method of generating service area domains will be modified so that bus-stop domains are generated.

To assume that bus-stops are a given fact, limits an important factor in bus routing. Therefore the creation and designation of bus-stops based on an automated method is important to the new approach. Traditional bus stops, which are used year after year, must be evaluated very carefully. Using the locations of the students residence, in conjunction with adjustable criteria for defining the service area of a bus-stop, adds a factor that may be varied in order to optimize the bus routing solution. It will also insure that a minimum number of stops are generated for a given area and that each service area for a bus stop will be defined so that the students in all areas will have about the same distance to walk to a stop. Also, if each stop is about the same size, the problem of large numbers of pupils at selected stops is minimized. Once an optimal set of bus-stops are defined, using the automated results as modified by district officials, then the actual routing may be attempted.

"Costs" refer to the units in the program that are to be maximized or minimized. The analysis of "costs" in a bus routing application may be done three ways. The first cost is distance. The distances to be minimized may be determined from a map with an identifiable scale. In the automated approach, the DIME file may be used to measure distances between points, over road distances on the street network.

The second cost to be minimized is time. On an automated approach, some travel times are estimated by applying a constant speed to each link but times for other links must be specified more precisely. This requires that additional network characteristics data must be coded in the DIME file. The following items can be calculated and added to the file: student travel time on the bus, bus time required and total route time (for scheduling multiple routes for a bus). Additional time related costs must also be included in the analysis, such as: driver pay scales, bus maintenance costs, fuel costs, trade-offs between student walking and dollar operating costs of driver/bus, costs of the bus while stopped versus costs while in motion, costs of stopping and starting at each stop.

Reports

Since the reports to be generated by the system are based on the data from the algorithms used, programs will have to be written to generate special reports based on the CRAM, CARPOL and other output. These will include useful report items from all software developed.

The reports produced will be a compilation of the best reports produced by all the previously developed school districting packages studied. These reports may also be supplemented with graphics from existing plotting programs. Additional reports will be generated, if deemed necessary by local school planners. Automatically generated bus passes for the students is one type of potential output. Bus route directions for bus drivers is another possible output which is possible within the planned system. A prototype report for a sample school allocation is attached.

Prototype School District Summary Report

Facility: PS 142   Grades: K-6

Location: Las Vegas, Nevada   High Hills Section

District Boundaries:
Adams Street NW
Hillside Avenue SE
Grant Blvd. NE
Raster Street SE
Oak Street SW
Willow Lane NE
Adams Street Comp

Size: 1000   Critical: 1200   Current: 970   Planned: 1070

Difference: +20   -130   +100

Distance: 1 Mile or less   1020   2 Miles or more 50

Budget Costs: $1200. per year

Category	Sub Category	Kindg.	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	Grade 6	School
	Male	20	45	70	95	100	115	75	520
	Female	25	45	30	110	95	100	70	510
	White	30	85	135	190	175	190	130	970
	Negro	15	10	10	15	15	15	20	100
	Other	--	--	--	--	--	--	--	0
Language	Span Lang	3	4	7	2	1	--	--	17
Other	Poverty	5	5	5	5	8	5	5	37
	Unemployed	2	2	3	2	1	3	6	24
	Female Head Household	10	--	--	12	8	18	10	74
Educational Backgd (yrs com	College	14	20	90	80	80	94	81	419
	High School	10	20	20	15	15	16	13	111
	Elementary	--	--	--	--	--	--	--	--

Prototype Bus Route Summary Report

Bus-stops - where and what order

Student minutes for trip - total

Route capacities

Students per bus by route

Trip duration - 1st stop to school - maximum student minutes

Bus route - graphically

Bus route - driving instructions for driver

Bus-Stop - location and list of students

Automated generation and mailing of student bus permits with stop location, time (pickup/delivery), effective dates, route number

Bus route time at each point (pickup and delivery)

School opening and closing times

Assign students to specific seats in bus - printed on bus permit

Print each stops pupil distribution (elementary, junior, high school)

Total bus mileage for maintenance

Dead head time and mileage

Full load dead-heading time

3. Population Projection

Preparing short term projections of school enrollments are necessary for classroom planning on a term to term basis. Long term projections are required in planning for the construction of school facilities. In addition, long term projections are also needed to suggest adjustments where the number of pupils may differ significantly from the available school capacities.

In general, need for school projections has become increasingly more critical. Funds for education have become more difficult to obtain without detailed projections. Coping with the increasingly complex problem of desegregation has required detailed data about the future racial or ethnic population groups.

It is difficult to develop projections specific to the needs of the educational planner. First, the total size of the population in some places changes rapidly and significantly. Rapidly growing areas house their pupils in over-crowded schools while some declining central city core areas have facilities with few or no pupils. Secondly, the ethnic composition of the population has been changing in ways which aggrevates the problem of racial balance. The residential concentration of the blacks in the central core city areas has increased in many areas as affluent whites move to suburban areas.

Because school districts in this country represent independent units of government which serve well defined client population groups, their geographic boundaries are not usually coterminous with the boundaries of other municipalities. As a result, data collected by other agencies - potentially useful in planning - may not be compatible with school areas. Also, since school facilities generally serve small areas, the statistics collected for these areas are likely to be quite variable.

Several dimensions need to be specified in projecting school enrollment. The first covers the geographic areas involved, i.e., what is the smallest areal unit for which projections will be needed, the largest areal unit, and the relationship between the two? The second concerns the time span for the projection: how far ahead and for what period will the projections need to be developed? Lastly, characteristics of the population need to be projected. Total enrollment is not enough; for each school, age, sex and race must be estimated to be useful.

Several different levels of areal units may be involved. The school district, as a whole, would represent the total aggregation of the areas below and would also represent the attendance zone for special classes for the handicapped. The enrollment areas, or attendance zones, for each school are represented as the elementary school level, the junior high school level and the high school level. Depending upon the arrangement of the feeder schools, the intermediate levels may also represent an aggregate of lower levels. A third possible level is represented by the sub-units of any or all of the above. At this level all residents would be treated as a whole, whether for bussing or zoning. This level represents the smallest unit to which individuals would be aggregated and make up the building blocks for any future district changes.

Projections are easier to develop for the short-term, i.e., a period running from two to four years into the future, than for the long term. Long term projections involving a period of time from 5 to 25 years into the future would require a detailed projection model. Projections should be developed for each of the three years after the current one. Thus, a projection prepared during the 1976-77 academic year would be for the 1977-78, 1979-80, 1980-81 academic years. The projections need represent only a single point during the year, probably October, to coincide with the reporting requirements of the school district.

Attention must be given to developing projections for racial groups to be attending a particular school. Those pupils attending a particular school must also be differentiated by grade or alternatively those attending a particular school would be differentiated by their residence within the smallest sub-enrollment areas.

Data resources can be expected to be of differing value and availability in projecting populations. The set of data of most value in projecting the population would be a recent historical series of the data characteristics to be projected. These data are needed to be able to relate to other data and to emphasize the continuous aspects of the projected data.

Data which can be directly connected to the historical series of school population are important for long term projections. Births, deaths and school records data are important. Births represent the source of persons enrolling in school in future years. The two figures, births and enrollees, are not likely to be identical due to deaths and migration, but their relationship over the years can be helpful. Death records can help to determine the racial trends in neighborhood development. School district records can also be of material assistance. Pupil records can provide information on the characteristics of the housing unit and the members of the household. In addition school transfer records are useful in developing information on patterns of migration in and out of districts and within districts.

The geographic location of student identification records is required to develop small area population projections and can be done through geocoding the source data records. Traditionally, the residence of the pupil is used to determine the school which he has to attend. Assuming neighborhood schools, a child attends the school nearest his home. If pupils may attend a school of their choice, geographic identification becomes more difficult and a historically continuous data series for particular residential area is difficult to obtain.

The county unit is a tabulating unit of a large volume of administrative data as well as census data. Current population estimates are available for the county from a variety of sources, including the Census Bureau under the Federal-State Cooperative Program.

The smaller the area, the greater the chances of sudden or rapid changes in population. In addition, the volume of data available to monitor changes are likely to be small. In the case of short term projections, simple extrapolation may not produce an error outside an acceptable range of tolerance for a small area. However, long range projections need to take more factors into consideration in order to avoid compounding errors. Small area projections are likely to need considerable local information to compensate for the variability of the small numbers involved.

- Several population projection methods can be used:

The Extrapolation of trends is the simplest and crudest technique available. Nonetheless, the technique is appropriate and useful for those areas which are relatively stable, either in changing or not changing. This method is useful where the projection period is short, e.g., one year ahead.

The Ratio Estimation technique is based upon the availability of a projection for the total population to which is applied the ratio between the total population and the school population. The ratio would be developed on the basis of some benchmark year, e.g., 1970 from the Census Bureau. The technique rests upon the validity of the projected total population figure and the assumption with respect to the changes taking place in the ratio. The need for small area base population projections and small area ratios make this difficult to use. The assumption that although an area may change the ratio of students to total population will remain constant is also troublesome.

The School Census Survival technique is the most widely used. The technique uses data already being collected by school administrators. This technique assumes that the school population represents a distinct group with its own patterns of survival through school as well as movement among areas. Thus, the historical experience of grade succession is assumed to reflect both physical survival and geographic movement. Averaged as a historical series, survival ratios can be used on existing data for short term projections and upon projections of births for longer term projections. Large scale movements, e.g., geographic or from parochial to public schools, weaken the validity of these survival ratios.

The Housing Unit - Pupil Yield technique is based on the ability to relate the pupil count to the current or planned and potential dwelling unit counts within an area. For this technique data on location and number or existing units, as well as those under construction, under permit, or projected, need to be collected. Some of these data on existing units may appear in the school records, but other data need to be collected from local building departments or tax assessors.

The Multi-variable technique relates changes in a number of different data series to changes in population distribution through a regression equation. This technique depends upon the existence of a body of data sufficient for projections and relevant to the problem. Computer processing enables the user to examine the empirical relevance of expected theoretical relationships between many variables and the desired one or between many variables and changes in the desired one. The Census Bureau uses this technique at the county level for some total population estimates. There is some difficulty, however, in applying the technique at smaller area levels for components of the population.

The Markov Process technique treats each grade as a state with probabilities attached to reaching successive states. The lack of appropriate data and the fact that the transition probabilities, i.e., the changes of going from one grade to another, usually remain stationary have limited the use of this technique. At the moment, the Markov model technique appears to be a useful tool for modeling population movement as well as for making projections. By distinguishing between various groups whose population characteristics are likely to be significantly different the use of this type of model is enhanced. In those terms, ethnic groups would be considered separately as would housing types. This can also be done by treating the areas of residence as distinguishable in terms of patterns of growth. Another alternative would be to consider the household residing in an area as representing particular stages in the life cycle and therefore with different implications for population change.

The choice of the unit for which projections will be made and the technique to be used should wait until the data resources are examined. Whatever the level involved, a range of projections will be generated. Each projection should be provided with a degree of probability concerning an increment or decrement so that the significance of the data can be evaluated by the educational planner. Many times, several projection techniques are used and then the results averaged together to obtain the most probable occurrence which is independent of any single method of population projection.

The basic assumption behind this is that projections will be useful enough to justify being prepared on an annual or biennial basis. Projection techniques should not be developed in order to prepare projections at just one point in time. As it becomes possible to compare the projections to the actual figures, most new information will be used to adjust or modify the techniques used. If the projections are to become a routine administrative task, then the collection, acquisition, and processing of the data can be treated as part of a larger information system and integrated into the operation of the school system.

Different projection techniques used with different data will provide a variety of ways to view the school system development. Properly developed and used over time, this information provides a basis for both understanding the changes taking place in the system and assessing the impact of planned or expected changes. The projections, combined with the judgment of knowledgeable local officials, will prove useful in providing guidance to school administrators.

III. Estimated Man Months of Effort	Detail	Sub-Total
GBF/DIME File Creation	Ongoing	
Update segments	Ongoing	
Add x/y coordinates	4 mo	
Map file	1 mo	
Edit DIME file	1 mo	
Update DIME file coordinates	1 mo	
Re-edit 1	1 mo	
Add school information per school	1 mo	
Add school facility codes, current bus stop codes	2 mo	
Current zones, facility capacity	1 mo	
Alternative sites for expansion	1 mo	
Documents requiring additions to file	1 mo	
Re-edit 2	1 mo	
Map file with additions	1 mo	
Correct	1 mo	
Re-edit 3	1 mo	
Do final maps	1 mo	19
Define interactive district procedure	1 mo	
Define policies to be investigated	1 mo	
Set up coordinate retrieval	3 mo	
Test district/site input	3 mo	
Set up school district report	3 mo	
Set up DIME node network input	2 mo	
Test district/site input	2 mo	
Set up school district report	3 mo	
Define additions needed for interactive districting	2 mo	
Evaluate usefulness of interactive generation	1 mo	
Set up computer map reports	1 mo	
Test GRIDS	1 mo	
Test plotter maps for large maps	1 mo	
Define additional nodes for map generation	1 mo	
Evaluate usefulness of maps generation	1 mo	26
Determine which current school data to add to files	1 mo	
UNIMATCH current school data	1 mo	
Correct file or data as necessary	1 mo	
Evaluate match with DIME file	1 mo	4

Determine specifications for school site model	1 mo	
Develop rough site value, building or demolition cost, facilities model	3 mo	
Test cost model	3 mo	
Set up school facility construction or closure cost model	1 mo	
Define additions needed for school site finance	1 mo	
Evaluate usefulness of model	1 mo	10
Generate CRAM network	1 mo	
Define policies to be investigated with CRAM	1 mo	
Set up CRAM for school application	2 mo	
Test CRAM	2 mo	
Model CRAM	5 mo	
Set up CRAM records	5 mo	
Link CRAM to boundary or node input	2 mo	18
Compare automatic generated abstracts with coordinate retrieval	1 mo	
Update DIME file for roadway information (GRIDS)	2 mo	
Generate network for bus tests	1 mo	
Define policies to be investigated with bus line system	2 mo	
Set up CARPOL for school application	3 mo	
Test CARPOL	2 mo	
Modify CARPOL	4 mo	
Set up CARPOL records	3 mo	
Link to CRAM Model	2 mo	19
Establish rules for program monitoring and input	1 mo	
Set up executive monitoring system to select alternative	4 mo	
Evaluate usefulness of executive carpool program	2 mo	6
Collect additional data for population programs	3 mo	

Examine socio-economic data for program	3 mo	
Set up program model	3 mo	
Set up migration data	2 mo	
Set up migration model	3 mo	
Run projection data using migration		
Set up projection models	1 mo	
Run projection components	1 mo	
Compare data output	2 mo	
		18
Evaluate and select population projection components	1 mo	
Integrate into school district program model	4 mo	
Set up final plan alternative concepts	2 mo	
Document system and components, develop educational materials	5 mo	
Hold training sessions	4 mo	
		16
Set up specifications for transfer site	1 mo	
Check DIME file/student assignment to transfer site	1 mo	
Set up program system	1 mo	
Set up student data files at transfer site	1 mo	
Run test programs at transfer site	2 mo	
Hold training session at transfer site	1 mo	
Write report on impact	2 mo	
Hold general training sessions	2 mo	
Distribute materials	1 mo	
Submit final report	2 mo	13
Total Man Months	150 mo	

IV. PROJECT SCHEDULE

MONTHS

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Begin Project																								
		Final Edits on DIME File					Preliminary Tests of Interactive Redistricting System				Begin Population Model					Close Project								
														Incorporate Projection Model							Public Seminar			
		ADMATCH Student Location								Test Site	School Model					Select Transfer Site								
				Maps of Student Locations			Generate Network for Boundaries/ Bus Assignments							Test CARPOL (Pupil Assignment to Buses & bus routing)					Begin Transfer of Technology					
											Test CRAM (Automated Redistricting Model													
																	Full Project Documentation							

LEVEL OF EFFORT (In Man Months)

											TOTAL
LOCAL	3	3	4	5	5	3	3	2	2	0	Est 180 MM
PROJECT	1	2	3	4	5	3	5	4	3	0	Est 150 MM

V. Past Approaches

Past manual techniques used in school planning involve several activities: Census materials or local data are used to determine school populations for towns, minor civil divisions, or school districts. If a local census is used, the data is usually coded to school areas. If U.S. Census material is used, cohort adjustments are made to estimate population demands for successive grades. These data are then placed on large maps with discussions of boundary and bus routes focusing on the impact of decisions on small groups within the total population.

In either case, the area for the school zone is dictated by many locally important considerations and adjustments to district boundaries is not made easily. As a result, school districts or bus routes may not meet local requirements but considering new alternatives may be prohibitively expensive. In addition, using manual methods, there is no way to set up plans which can be considered quantifiable objectives (maximize integration, minimize bussing costs) against which any other plan can be measured.

Past automated approaches toward school location problems can be generally characterized as one dimensional and incomplete. Most efforts have either been only a first step in solving any real complex problem or simply attempts to restructure the problem to allow for the use of a particular computer technique like optimization, route development, simulation or such.

The most important problem with previous automated school districting attempts is that few solutions have had the benefit of a full coding of the street network (DIME) as a resource upon which to build. This meant that previous efforts could not use a single standard data base to attack all of the problems associated with school boundary location problems. As a result past attempts were fragmented.

Past attempts at automating school redistricting usually used technology unsuited for large scale school problems. Because a standard data file with specific geographic data was not available, many solutions required a network of times which related the cost in traveling from one bus stop to another or to the school and these travel times were generally not available (Dreyfus). The inter-stop travel times were expected to be coded once and modified as needed. For a moderate or large scale district the task of compiling data is of such large scale that alternative option of the straight-line distance between stops as the travel time was used. Bus-stops may then have been grouped manually to further simplify the problem (Angel). By expanding the use of a standard file to zoning, bus routine, site location and projection, the total data collection effort becomes more worthwhile.

Automated school districting attempts in recent years have also been more concerned with optimizing some mathematically formulated function than in permitting the interactive use of the data by school planners (Clarke). These methods do not allow the school planner to control and direct the process of school redistricting by giving him the data he needs and the tools to work with. These processes dictate solutions to the user from which he might pick one to several to show to another decisionmaking group but the user cannot guide the development of solutions. Past attempts at integrating the planning in the system remain theoretical (S.D.C.) or rely heavily on manual methods (Glass).

In addition most of the approaches which concentrate on optimization cannot focus on the interaction between site location, district zoning and bus routing. The scope of considering all three facets of the problem (which must be faced by real school planners) is too broad for the commercial consultants to try to solve. There are, of course, programs available - at low cost - to minimize bus costs (Mathematia or A. T. Kearnay) but they cannot trade off school zoning or criteria for integration. Other projects have studied each section of the problem independently, such as zoning (Schuster) and bus routing (Norman). Usually, when the problem is considered in its complexity, many of the calculations required are approximated manually and simplifying assumptions of standardized bus capacity, bus stop capacity are used (Newton, Norman). In other cases where several factors are considered, the author worries about computer capacity (Liggett) or most keep his analysis at a theoretical level (Eastman).

Attached is a partial list of the major school planning programs that have been published. During this project, a continuing thorough review of all publications relating to school site locations, zoning, bus routing and population projection is recommended.

Appendix VI

BIBLIOGRAPHY

1. Angel, R. D., W. L. Caudle, R. Noonan, and A. Whinston, "Computer-Assisted School Bus Scheduling," Management Science 18(6):B279-288, February 1972.

2. Armitage, Peter and Cyril Smith, "A Computable Model of the Educational System, Illustrated with British Data," The World Year Book of Education 1967, pp. 423-439.

3. Banghart, F., et al, Simulation of Space Needs and Associated Costs, (Document No. 731702), Florida State University Educational Systems and Planning Center, Tallahassee, Florida.

4. Baisuck, Allen and William W. Wallace, "A Computer Simulation Approach to Enrollment Projection in Higher Education," Socio-Economic Planning Sciences 4(3):365-381, September 1970.

5. Belford, P.C. and H.D. Ratliff, "A Network Flow Model for Racially Balancing Schools," Operations Research 20(3):619-628, May-June 1972.

6. Birch, David L., "Toward a Stage Theory of Urban Growth," AIP Journal 37(2):78-87, March 1971.

7. Boyer, R. A., R. D. Ross, and T. A. Ross, "The Use of a Computer to Design School Bus Routes: A Status Report," Journal of Educational Data Processing 4(3):143-151, Summer 1967.

8. Cassidy, P. J. and H. S. Le s, "A Computer Program for the Organization of School Meal Delivery Routes," Quarterly Bulletin of the Research and Intelligence Unit of the Greater London Council 6:20-26, March 1969.

9. Clarke, G. and J. W. Wright, "Scheduling of Vehicles from a Central Depot to a Number of Delivery Points," Operations Research 12(4):568-581, July-August 1964.

10. Clarke, S. and J. Surkis, "A Operations Research Approach to Racial Desegregation of School Systems," Socio-Economic Planning Sciences 1(3):259-272, July 1968.

11. Cross, Ray and Charles H. Sederberg, "Computer-Assisted Enrollment Projection Procedures," (Computer Assistance: Paper No. 2) Journal of Educational Data Processing 5(4):160-165, Fall 1968.

12. Denham, Carolyn H., Probabilistic School Enrollment Predictions Using Monte Carlo Computer Simulation, Boston College, Chestnut Hill, Mass., May 1971.

13. Dost, James, "Determination of the Location for an Area School," Paper presented at the Western Regional Science Association Meetings, Las Vegas, Nevada, January 1967.

14. Dreyfus, S., "An Appraisal of Some Shortest Path Algorithms," Operations Research 17(3):395-412, May - June 1969.

15. Eastman, C. M. and K. O. Kortanek, "Modeling School Facility Requirements in New Communities," Management Science 16(12):B784-799, August 1970.

16. Ellena, William J., Loyal W. Joos, and John C. McLaulin, Predicting Pupil Yield by Types of Dwelling Units, U.S. Dept. of Health, Education, and Welfare, Office of Education, Washington, D.C., n.d.

17. Engelhardt, N. L., "How to Estimate Your Future Enrollment," School Management 17:38, June 1973.

18. Fabricant, Ruth and Janice Weinman, "Forecasting First Grade School Enrollment by Neighborhood," Demography 9(4):625-633, November 1972.

19. Francese, Peter K., "Estimating Population for Census Tracts in 1973 and 1974," Paper presented at the Annual Meeting of the American Statistical Association, August 26-29, 1974, St. Louis, MO.

20. Glass, Robert I., "Computers Enter the Busing Controversy," Computers and Automation 20(7):18-23, July 1971.

21. Greenberg, Michael R., Donald A. Krueckeberg, and Richard Mautner, Long Range Population Projections for Minor Civil Divisions: Computer Programs and User's Manual, Center for Urban Policy Research, Rutgers University, The State University of New Jersey, New Brunswick, N. J., May 1973.

22. Greenberg, Michael R., "A Test of Combinations of Models for Projecting the Population of Minor Civil Divisions," Economic Geography 48(2):179-188, April 1972.

23. Hall, Fred L., Location Criteria for High Schools: Student Transportation and Racial Integration, (Research Paper No. 150), The University of Chicago Department of Geography, Chicago, Illinois, 1973.

24. Hansen, Glenn R. and C. H. Henderson, "Routing Know-How Including Computer Programming," Proceedings of the Association of School Business Officials of the U.S. and Canada, 52:478-493, 1966.

25. Heckman, Leila B. and Howard M. Taylor, Designing School Attendance Zones by Linear Programming (Research Report 7002), Cornell University Department of Environmental Systems Engineering, Ithaca, N. Y., January 1970.

26. Heckman, Leila B. and Howard M. Taylor, "School Rezoning to Achieve Racial Balance: A Linear Programming Approach," Socio-Economic Planning Sciences 3(2):127-133, August 1969.

27. Hurnard, John R., The Development of a Procedure for Improving Decisions about School Attendance Areas, University of Oregon, Bureau of Educational Research, Eugene, Oregon, July 1972.

28. Ide, Edward A., "Address Coding to Produce Age-Race Data by City Block for School Planning," Socio-Economic Planning Sciences 4(1):107-118, March 1970.

29. Jaffe, A. J., Handbook of Statistical Procedures for Long-Range Projections of Public School Enrollment, (Technical Monograph OE-24017) US Government Printing Office, Washington, D.C., 1969.

30. Johnstone, James N. and High Philip, "The Application of a Markov Chain in Educational Planning," Socio-Economic Planning Sciences 7(2): 283-294, June 1973.

31. Koenigsberg, E., "Mathematical Analysis Applied to School Attendance Areas," Socio-Economic Planning Sciences 1(4):465-475, October 1968.

32. Levine, Summer N., "A Model of Racially Changing Neighborhoods," Socio-Economic Planning Sciences 1(1):477-479, January 1968.

33. Liggett, Robin Segerblom, "The Application of an Implicit Enumeration Algorithm to the School Desegregation Problem," Management Sciences 20(2):159-168, October 1973.

34. Maxfield, Donald W., "Spatial Planning of School Districts," Annals of the Association of American Geographers 62(4):582-590, December 1970.

35. McNamara, James F., "Mathematical Programming Models in Educational Planning," Review of Educational Research 41:419-446, December 1971.

36. Moore, E. F., "The Shortest Path through a Maze," Proceedings of the International Symposium on the Theory of Switching Harvard University Press, Cambridge, Mass., 1959.

37. Moore, Eric G., A Simple Model of Student Flows in an Urban School System (Research Report No. 5, Simu-School Study), Chicago Board of Education Dept. of Facilities Planning and Operations Analysis, Chicago, Ill., 1973.

38. Morrison, Peter A., Demographic Information for Cities: A Manual for Estimating and Projecting Local Population Characteristics (R-618-HUD), RAND Corporation, Santa Monica, California, June 1971.

39. Newton, Rita M. and Warren H. Thomas, "Design of School Bus Routes by Computer," Socio-Economic Planning Sciences 3(1):75-85, June 1969.

40. Norman, Michael J. and George S., "Computerized Route Planning for School Buses: Design and Implementation," (C-TP 2.13) Paper presented at the 36th National Meeting of the Operations Research Society of America, Miami Beach, Florida, November 10-12, 1969.

41. O'Brien, R. J., "Model for Planning the Location and Size of Urban Schools," Socio-Economic Planning Sciences 2(3,4):141-153, April 1969.

42. Otto, Robert Carl, Generating Housing Alternatives When Capacity Exceeds Enrollment, Newport-Mesa Univied School District, Newport Beach, California, 1973.

43. Parker, M. and J. R. Cerone, "Using a Computer to Project Enrollment Changes," School Management 14:14016, October 1970.

44. Ploughman, T., W. Darnton, and W. Heuser, "An Assignment Program to Establish School Attendance Boundaries and Forecast Construction Needs," Socio-Economic Planning Sciences 1(3):243-258, July 1968.

45. Revelle, Charles, David Marks, and Jon C. Liebman, "An Analysis of Private and Public Sector Location Models," Management Science 16(11):692-707, July 1970.

46. Ricketts, DeWitt E. and Melvin J. Thompson, "Data Processing Makes Busing Cheaper, Safer," Nation's Schools 77:82, April 1966.

47. Rosswell, Christine H. and Robert L. Crain, Evaluating School Desegregation Plans Statistically, The Johns Hopkins University Center for Metropolitan Planning and Research, Baltimore, Maryland, November 1973.

48. Schuerman, Leo A., "Population Composition Estimation: A Working Paper of Local Area Estimation," Proceedings of the 1973 Conference of the Urban and Regional Information Systems Association, 1974.

49. Scott, Allen J., An Introduction to Spatial Allocation Analysis, (Commission on College Geography Resource Paper No. 9), Association of American Geographers, Washington, D. C., 1971.

50. Schuster, Stewart Arnold, Locating Optimal Sites in Geographic Information Systems, (UIUCDCS-R-73-573), University of Illinois Dept. of Computer Science, Urbana, Illinois, June 1973.

51. Smith, Wallace F. Filtering and Neighborhood Change, (Research Report No. 24), University of California Center for Real Estate and Urban Economics, Berkeley, California, 1964.

52. Temkin, S., An Evaluation of Comprehensive Planning Literature with Annotated Bibliography, Research for Better Schools, Philadelphia, Pennsylvania, 1970.

53. Tracz, George S., "A Quantitative Approach to the Design of School Bus Routes," The Ontario Institute for Studies in Education, Ontario, Canada, 1970.

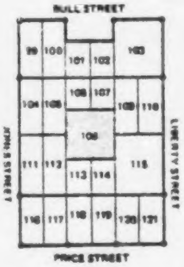
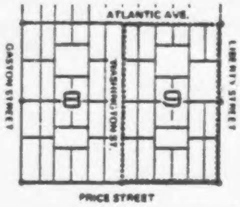
54. Tracz, George S. and M. J. Norman, A Computerized System for School Bus Routing, The Ontario Institute For Studies in Education, Ontario, Canada, 1970.

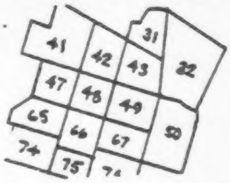
55. Webster, William J., "An Empirical Comparison of Selected Enrollment Projection Formulas," The Journal of Educational Research 64(8): 375-381, April 1971.

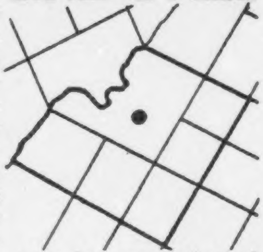
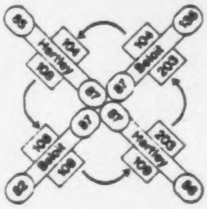
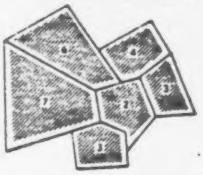
56. Werdelin, Ingvar, "A School Enrollment Model," International Review of Education 16(2):192-214, 1970.

57. Yeates, Maurice, "Hinterland Delimitation: A Distance Minimizing Approach," The Professional Geographer, 15(6):7-10, November 1963.

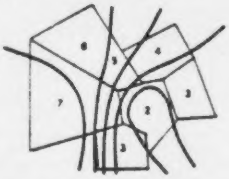
ADDRESS CODING GUIDE (ACG)	This file, census designed and locally produced, consists of an inventory of block faces with their associated street names and address ranges together with codes identifying specified geographic areas within which the block faces lie. Each record in this file contains information such as the ZIP code, the census tract, the street names and the lowest and highest address associated with that side of the street. Each record relates to odd-numbered or even-numbered addresses, never to both. A basic use is to permit the computer match of mail addresses for the assignment of geographic codes.
ADDRESS RANGE	A set of numbers representing the high and low limits of house numbers to be found on a specified length of street.
ADMATCH (Address Matcher)	A package of computer programs that provide the capability of geographically coding computerized data records containing street addresses. The system compares the addresses on input data records (after standardization with a preprocessor) with the address ranges in a reference file. A "match" occurs when the street names are judged identical or equivalent and when the address falls within the defined range. Geographic codes from the reference file may be attached to the matched data records. (See also UNIMATCH)
AREA DICTIONARY	A listing (generally locally prepared) of geographic units, e.g., census tracts and/or city blocks, which are parts of a specifically designated local geographic area to which a code has been assigned. Typical examples would be a list of the blocks by police precincts and a list of census tracts by health districts.

ARITHMICON	ARITHMICON is an interactive management system for the GBF/DIME-File. It includes the ability to select specific components from the file directly or indirectly, perform a series of edit checks, update and access the file, and with add-on routines, provide various kinds of network and geographic analysis. ARITHMICON is under development and is not available for general distribution.
BIT	The smallest element of binary machine language. A bit is represented by a magnetized spot on a recording surface or a magnetized element of a storage device.
BLOCK	A block is generally a well-defined piece of land, bounded by streets or roads. However, it may be irregular in shape or partially bounded by railroad tracks, streams or other features. Block-level statistics are tabulated for urbanized areas within SMSA's. The Bureau also tabulated data for blocks on a contract basis in over 900 areas outside urbanized areas.  BULL STREET 99 100 101 102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118 119 120 121 LIBERTY STREET PRICE STREET
BLOCK CHAINING	See "Chaining."
BLOCK FACE	A block face refers to the side of a city block. A typical city block contains four such block faces, each with a range of house or building numbers. No census data are made available for individual block faces.
BLOCK GROUP	A block group is a combination of contiguous blocks and generally has a population of about 1,000. For the purpose of providing small-area census data in the built-up portions of many SMSA's, a block group is the equivalent of the enumeration district.  ATLANTIC AVE. GASTON STREET WASHINGTON ST. LIBERTY STREET 8 9 PRICE STREET

CARPOL	An approach to large-scale carpooling using DIME Technology, designed to present applicants with lists of potential carpoolers who live nearby and who work similar shifts. This computer program's documentation is accompanied by administrative suggestions for executives and technical data for staff members not familiar with computer technology.
CATHODE RAY TUBE (CRT)	This device is used to display computer output. Computer programs are used to control the display generated and for permanent storage. The displays may be recorded on microfilm. A television screen is a form of cathode ray tube.
CCUS	See "Center for Census Use Studies."
CENSUS COUNTY DIVISION (CCD)	A statistical subdivision of a county in the 21 states for which the minor civil division (MCD) is not a suitable unit for presenting census data. This relatively permanent statistical area is defined by local administrative boundaries or by boundaries that seldom require change and can be easily located, e.g., roads, streams, etc.
CENSUS TRACTS	These Census-designated areal units are statistical subdivisions of SMSA's. Tracts are designed to be relatively homogeneous in population characteristics, economic status, and living conditions, though these conditions may change over time. The average tract has about 4,000 inhabitants. Census tract boundaries and boundary changes are recommended by local census tract committees and approved by the Census Bureau. As tracts increase in population, they may be split.  41 42 43 31 22 47 48 49 65 66 67 50 74 75
CENSUS USE STUDY (CUS)	See "Center for Census Use Studies."
CENTER FOR CENSUS USE STUDIES (CCUS)	A user-oriented research, development and demonstration unit of the Bureau of the Census, it acts as the Bureau's focal point for applied

CENTER FOR CENSUS USE STUDIES (CCUS) (Cont'd)	research. It investigates innovative ways in which data can be used more effectively by local, State, and Federal agencies. Its capabilities include research and demonstration projects, the development of technical and methodological tools, and the development of communications methods to effectively relate technical uses of data to non-technical users.
CENTROID	The center point for an area such as a census tract, census block or block group and described by a coordinate pair. The centroid coordinates may be computed by a digitizer from the boundary coordinates appearing in DIME files and a program (DACS) is available for this computation. Alternatively, centroids may be approximated clerically. 
CENTS	See "COCENTS."
CHAINING	The process of logically constructing a connected set of DIME segments ordered so that the end point on any one is the same as the beginning point on the next. In "chaining around a block" the ending node on the last segment should be the same as the beginning node of the first. In "chaining around a node" the left and right block numbers serve as connecting points. 
CHOROPLETH	A map on which shaded areas conform to specified boundaries, i. e., census tracts or city limits. The entire area to be represented is given the same value and shading is assigned according to the unit's numeric class. 

COBOL	Common Business Oriented Language: A computer programming language, appropriate for business and other file manipulation problems.
COCENTS	A generalized report generating system capable of producing tabular results from many types of statistical data. It provides a method of rapid tabulation of population and housing data from national censuses in developing counties throughout the world. COCENTS can also be used to prepare tables from local data files or from the public use samples available from the Bureau of the Census. COCENTS is the COBOL version of an earlier program, CENTS, written in assembler language.
COMPLETE COUNT OR 100% DATA	Items of information collected for every individual and housing unit at the time of the census. They constitute the basic facts about people and housing such as age, race, sex, rent, and number of rooms.
COMPUTER GRAPHICS	The production of maps and other visual displays by computer. Large amounts of data can be displayed in varying patterns on maps and graphs, thus making spatial relationships and trends immediately apparent. Three common types of devices used to display computer output are: computer line printers, pen plotters, and cathode ray tubes.
COMPUTER RESOURCE ALLOCATION MODEL (CRAM)	A computer tool based on the GBF/DIME-file that is designed for use in facilities planning (schools, service agencies, recreational facilities). It is a generalized facility location system that allocates demand among a set of available facilities according to their capacity to supply services, street accessibility, and access time.

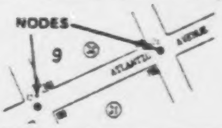
CONFIDENTIALITY	The same law (Title 13, U. S. Code) which requires a person to answer Census questions to the best of his knowledge also provides that information received by the Census Bureau must be held in confidence and may be used only for statistical purposes. Therefore, information about any individual person, enterprise, etc., may not be released without the written authorization of the person or legal representative of the person or unit involved. In addition, the information may not be used for taxation, regulation or investigation.
CONFORMAL	See Choropleth.
CONTOUR	A contour map is one based on the use of contour lines, each of which represents a uniform value throughout its length. Data values are assigned to particular points (such as block face centers or block or tract centroids) and contours are shaded at intervals representing the range of values between each pair of points. 
COORDINATES	A pair of numbers used to specify the location of a point on a map or globe. Coordinate systems used in GBF/DIME-files are latitude and longitude, state plane and, metropolitan map set.
CORRECTION, UPDATE AND EXTENSION PROGRAM (CUE)	A Census Bureau program designed to update, correct and extend the GBF/DIME-file and Metropolitan Map Series, and to develop procedures by which each SMSA can systematically maintain current and accurate files and maps.
COUNTS, FIRST-SIXTH	The terms used by the Census Bureau to identify sets of 1970 census data summaries on computer tape for certain kinds of geographic areas. Numbering refers to the order in which they were released.
CRT	See "Cathode Ray Tube."

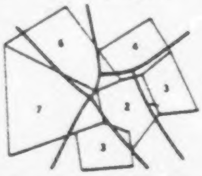
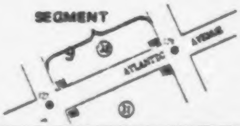
CUE	See "Correction, Update and Extension Program."
CUS	Census Use Study. See "Center for Census Use Studies."
DACS	A flexible computer system for locating centroids and calculating areas (square acres, miles) for blocks, block groups, census tracts, etc. from the GBF/DIME-Files. It is written in FORTRAN for medium-sized computers. Centroid location is required primarily as input to GRIDS and other map generating computer packages.
DATA USER SERVICES DIVISION (DUSD)	The Service Division of the Bureau of the Census concerned primarily with making census data more accessible and useful to users in government, private industry and the academic community.
DIGITIZING	A semi-automatic process of assigning coordinates to specified map locations.
DIME	See "Dual Independent Map Encoding."
DOMAIN (record linkage)	The set of reference records considered as possible matches to a given data record. In ADMATCH, the domain for a given data record is the set of reference records with the same state, place, street name, and parity.
DUAL INDEPENDENT MAP ENCODING (DIME)	The dual independent map encoding (DIME) technique is a system for representing map features numerically for processing by computer. A file of segment records is created in which a typical segment is a portion of a street defined by intersecting streets or civil boundaries. Other segments may be defined for natural features, railroad tracks, jurisdiction boundaries, and the like. The basic feature of the system is that each node (intersection) and block (area bounded by segments) is uniquely identified. "Dual Independent" refers to the fact that each boundary segment in the network is described by specifying the nodes at the ends and the blocks to the right and left. With each node and block uniquely numbered, the computer can then construct two independent networks and match them to insure the existing network is completely

DUAL INDEPENDENT MAP ENCODING (DIME) (Cont'd)	represented and all land accounted for. Spatial information is added to the file by assigning geographic coordinates to each intersection node.
DUSD	See "Data User Services Division."
ECONOMIC CENSUSES	Taken by the Bureau of the Census every five years, the economic censuses are a major source of information about the Nation's industrial and business activities. Areas covered by the censuses include: retail and wholesale trade, selected services, construction, manufactures, mining and transportation.
ENUMERATION DISTRICT (ED)	The smallest unit for which data are tabulated outside the 1970 census mail out/mail back areas. ED's have an average population of 800 and are redefined with each census for use as administrative units for control of census operations.
FILE	A collection of records containing data about specific units, e.g., persons, housing units, or census tracts. As organized for data processing, the contents of the records are prepared on cards, tape, or disk.
FIXDIME II	This computer program edits locally prepared correction inputs to the GBF/DIME-File for completeness and consistency and inserts the accepted corrections to the file.
FLOWCHARTING	A graphical representation for the definition, analysis or solution of a problem, in which symbols are used to represent operations, data or flow. INPUT PROCESS OUTPUT
FORTRAN	Formula Translation: A computer programming language appropriate for mathematical problems.
FOSDIC	Film Optional Sensing Device for Input to Computer. Part of a census document reader capable of reading the contents of microfilm by optical methods and converting the information codes to magnetic tape.

GBF/DIME-FILES	Computerized maps produced by the Bureau of the Census for metropolitan areas. GBF/DIME stands for geographic base file/dual independent map encoding. The GBF/DIME-File contains local address information such as street names, intersections and ZIP codes, as well as geographic or statistical area identifiers such as census blocks and tracts, counties, etc. Other identifiers can be added by users to include local statistical areas such as police precincts, school districts, and transportation zones. See also "Dual Independent Map Encoding," "Geographic Base File," and "GBF/DIME System."
GBF/DIME SYSTEM	A package of computer programs for establishing, maintaining, and using GBF/DIME-Files. See also "GBF/DIME-File."
GEOGRAPHIC AREA CODE INDEX (GACI)	The Geographic Area Code Index contains geographic codes for each State, county, minor civil division or census county division, and place in the U.S., thus providing a means of associating area names with the geographic codes on summary tapes. It is an abbreviated version of MEDList and does not contain population and housing unit counts. (See MEDList)
GEOGRAPHIC BASE FILE (GBF)	See "GBF/DIME-File."
GEOGRAPHY DIVISION	The Division of the Bureau of the Census that provides the geographic services required by the Bureau's data collection and geographic classification programs. It is responsible for the implementation of the CUE program, for maintaining and updating the GBF/DIME System.
GRIDS	A computer mapping system which produces character-printed maps from detailed data. GRIDS is written in ASA Basic Fortran IV and has several mapping options available.
INTERSECTION	The point at which two or more streets or nonstreet features, such as boundaries, meet.

LINE PRINTER	A standard computer output device which generates printed images such as computer maps or tables.
LINK	The segment of a street, natural boundary, or artificial boundary forming a connection between two nodes.
MAP SET MILES	A coordinate system used for DIME files along with latitude and longitude and state plane. Coordinates are in decimal miles from an arbitrary point southwest of the area covered by the Metropolitan Map Series.
MCD	See "Minor Civil Division."
MEDList	The Master Emmeration District List is a listing of names of political and statistical subdivisions and related geographic codes from the State down to the county subdivision and place level. It also provides codes for unnamed areas below the county subdivision level (tracts, ED's, and BG's) as well as population and housing unit total counts. A version of this file is available that also contains latitude and longitude of the centroid of the ED or block group.
METROPOLITAN MAP SERIES (MMS)	A set of maps created for the 1970 Census for the urbanized area of every standard metropolitan statistical area (SMSA). They contain streets and street names and all census-recognized boundaries down to the city block level, and are published in the block statistics reports of the 1970 census. County and place maps are generally available for areas not covered by the MMS.
MINOR CIVIL DIVISION (MCD)	A primary political and administrative subdivision of a county. The most common type of MCD is the township although precincts, magisterial districts and gores are also included in this classification.
MMS	See "Metropolitan Map Series."

NETWORK	The transport facilities, streets, telephone lines, etc., of an area conceived in a linear form where direction, volumes, and speed are variables commonly used as the basis for developing models.
NODES	Points established at intersections, dead ends, sharply curving portions of all street and non-street features to which unique numbers have been assigned. 
ORIGIN/DESTINATION (O/D) SURVEY	A survey to determine the origin and destination of a particular motor vehicle trip. The data gathered is generally used for transportation planning.
PEN PLOTTER MAPS	A graphic output produced by a pen physically moved over a piece of paper under computer program control.
PLACE	There are two types of places recognized in census products—incorporated and unincorporated. Incorporated places are political units incorporated as cities, towns, villages, or boroughs. Most incorporated places are subdivisions of MCD's or CCD's. Unincorporated places are closely settled population centers without legally defined corporate limits.
POINT-IN-POLYGON TECHNIQUE	A method for mathematically calculating whether a specific point falls within a defined area.
POSTPROCESSOR	A computer program used with OS ADMATCH for reformatting ADMATCH output files. It allows the user to re-create his original data records by merging the geocoded data into the body of the record. Rejected or accepted records may be separated or combined for further processing.
PREPROCESSOR	A computer program used with the ADMATCH or UNIMATCH system. The program recognizes "free form" street addresses and standardizes them by creating a fixed field "match key" or standardized framework and converting all common abbreviations to standard forms or codes.

PROXIMAL	A type of map on which data values are assigned to particular points (block face centers or block or tract centroids). The area from each point to an imaginary line equidistant between each pair of adjacent points is shaded with the respective value. 
PUBLIC USE SAMPLE	A sample of census basic records for individual households; made available for statistical use outside the Census Bureau. Identifying information, such as name and detailed geographic location, is omitted to preserve the confidentiality of the census records.
SAMPLE DATA (20%, 15%, 5%)	More information is collected in the census from a selected portion of the population than from the total population. The selection, done by scientific sampling methods, permits the development of data about an area at a much lower cost than obtaining data from all persons. However, the size of the sample restricts its use for a small geographic unit. The 20% and 15% sample data such as income and employment characteristics, for example, are considered sufficiently reliable for census tracts, but generally not for smaller units such as city blocks. For the same reason 5% data such as disability or marital history are generally not published for areas smaller than SMSA's, States or large cities.
SCANGEN	A computer program designed to produce an inexpensive and simple means for producing choropleth maps from a basic boundary file.
SCRIS	See "Southern California Regional Information Study."
SEGMENT	The term is used to refer to a line (street or non-street feature) between two nodes in the GBF/DIME-File. 

SMSA	See "Standard Metropolitan Statistical Area."
SOUTHERN CALIFORNIA REGIONAL INFORMATION STUDY (SCRIS)	A joint research and development project of the Census Bureau and the Southern California Association of Governments. It was transferred to the County of Los Angeles in 1972.
SPLITS	This computer program is designed to split the street segment records of the GBF/DIME-File to block face records. These records may then be used for input to the ADMATCH program.
STANDARD METROPOLITAN STATISTICAL AREA (SMSA)	A statistical area defined by the Office of Management and Budget and consisting of a county or groups of counties containing at least one city (or twin cities) of 50,000 or more population, plus any adjacent counties which are metropolitan in character and economically and socially integrated with the central county or counties.
STATE PLANE COORDINATES	A grid system overlaying an area, e.g., a State, or portion of State, with grid lines uniformly separated in distances measured in thousands of feet. Through the use of the coordinate system the location of points, distances and direction between points, and areas can be calculated.
SUMMARY TAPES	Aggregations of data collected from the 1970 census. These tapes contain more data than are available in the published reports. (See also "COUNT").
SUPPRESSION	The insertion of a code to replace an actual value in order to prevent disclosure of information concerning an individual or firm.
SYMAP (Synagraphic Mapping)	This software package, currently maintained by the Harvard Laboratory of Computer Graphics, produces geographic output using a standard high-speed printer. With a wide range of options available, raw data may be statistically processed in various ways and displayed in 3 basic map types: 1) conformal, 2) contour, and 3) proximal.

UNIMATCH (Universal Matcher)	An improved matching system that has many capabilities not available in ADMATCH such as the ability to handle building names, street intersections and non-address matching. It is a generalized record linkage system which will compile, assemble, and execute a file matching system tailored to the specific needs of the user.
URBANIZED AREA	An urbanized area consists of a central city (or "twin cities") of 50,000 or more population plus the surrounding closely settled, incorporated and unincorporated areas which meet specific criteria of population size or density. Urbanized areas differ from SMSA's in that rural portions of the counties composing an SMSA are excluded, as are those places which are urban in nature but separated by rural territory from the densely populated area surrounding the central city. There is generally one urbanized area in each SMSA.
ZIPMATCH	A system developed for the U.S. Postal Service for assigning ZIP codes to mailing address.
ZIPSTAN	An improved and redesigned system for standardizing addresses. It converts addresses into a standard form suitable for input to UNIMATCH.

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
OFFICE OF THE ASSISTANT SECRETARY FOR EDUCATION
WASHINGTON, D.C. 20202

SEP 30 1976

Mr. Ramon Hilario
Director of Bilingual/Bicultural Education
The Edison School
440 W. Homita Avenue
Glendale, California 91204

Dear Mr. Hilario:

You are cordially invited to participate at one of a series of conferences co-sponsored by the U.S. Office of Education and the National Institute of Education. The purpose of the conferences is to solicit ideas on the establishment of the National Clearinghouse on Bilingual Education.

The aforementioned agencies are mandated in the Bilingual Education Act (P. L. 93-380) to establish a clearinghouse for the express purpose of collecting, analyzing and disseminating information about bilingual education and related programs. We feel that it is of prime importance to involve the potential users in the planning stage to enable the clearinghouse to be as useful and responsive as possible. These conferences will be your opportunity to tell us how the clearinghouse can best serve your needs.

The conference to which you are being invited will be held on October 12, 1976 at San Diego, California. You will be reimbursed for your travel and allowed per diem at a standard Federal rate for your geographic area. Please complete the enclosed information sheet.

Sincerely,

Acting U.S. Commissioner
of Education

Harold L. Hodgkinson
Director,
National Institute of Education

in 1969 to ten in 1974-76. The original five have maintained themselves over the eight years, with only one exception. "Facilities" has been displaced as a problem in 1976. Discipline, "good" teachers, finance and desegregation continue to worry the public.

Since 1970, drug use has been listed. The disinterest of parents and the curriculum made the list in 1972. Disinterested students was added in 1975. In 1974 and again in 1976, schoolboard policies were seen as problems.

Education Writers

Nine sources[1] show that those who observe and study the education-

---

[1] Definition of the sample: Seven metropolitan dailies were chosen at random for interviews with their education editors (Boston Globe, New York Times, Washington Post, Kansas City Star, New Orleans Times-Picayune, LosAngeles Times, and Seattle Times.)

In addition, a popular weekly magazine with an education section (TIME) was examined for this year and a content analysis made of its articles. A scholarly magazine (Harvard Educational Review) was likewise examined.

To determine problems seen by associations, a search was first made for representative journals. Those of the NEA, the NASSP, and the NSBA were content-analyzed for 1976. To arrive at a more official statement of what associations strived for, the platforms and resolutions for 1975 and 1976 were examined for the AASA, AFT, CCSSO, NEA, and NSBA. CCSSO's Critical Issues in Education, compiled from Chiefs' papers and their 1975 Institute, was used. It is their classification of problems which forms the base for Tables 2, 3 and 4.

Admittedly, these samples cannot be held to equate the rigor of the Gallup poll. They do, however, serve to display the range of concerns, the deployment of energy, and the depth of belief of the education writer and associations.